City of Patterson Water Master Plan
Final Report

Prepared by:

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List of Abbreviations

AF	Acre-feet
AFY	Acre-feet per year
APN	Assessor Parcel Number
CDP	Criterium Decision Plus
CIP	Capital Improvement Plan
CVP	Central Valley Project
DMC	Delta-Mendota Canal
DWR	Department of Water Resources
EPA	Environmental Protection Agency
gpcd	Gallons per capita per day
gpm	Gallons per minute
GSP	Groundwater Sustainability Plan
HCF	Hundred cubic feet
LF	Linear feet
MCL	Maximum contaminant level
MG	Million gallons
NPWP	Non-Potable Water Program
O&M	Operation & maintenance
OYS	Operational Yield Study
ppb	Parts per billion
ppm	Parts per million
RO	Reverse Osmosis
RW	Recycled water
SGMA	Sustainable Groundwater Management Act
SJR	San Joaquin River
SOI	Sphere of Influence
SWP	State Water Project
SWTP	Surface Water Treatment Plant
TDS	Total dissolved solids
WMP	Water Master Plan
WQCF	Water Quality Control Facility
WSA	Water Supply Assessment

Executive Summary

ES-1 Project Introduction

The City of Patterson (City) is growing and, based on the 2010 General Plan Update, could reach a population of 67,000 (approximately triple the current population) at build-out, with over 50,000 people in 2040. Water demands within the City's service area are currently around 3,300 acre-feet per year (AFY), and expected to rise to around 9,400 AFY within the next 20 years. Currently, potable supplies are reliably provided solely by the City's groundwater well network, coupled with some non-potable sources and significant water efficiency measures in on-going programs by the City. While the approach of using conservation and groundwater to serve new growth can still be a solid component of the City's supply for the future, the water resources landscape in California has significantly changed in recent years. There is a realization across all sectors in the water industry that significant transformation may be needed in the way California's water is managed. This has been triggered by the recent drought, which is one of the most severe droughts in the State's history, as well as significant legislation that impacts the way we use and supply water. The Sustainable Groundwater Management Act (SGMA) is part of this new context that may impact the City's ability to rely on historical approaches for supply development. With the expected growth, and the new context and restrictions in which new supplies will be developed, the City embarked in a comprehensive Water Master Plan (Master Plan) to rigorously evaluate potential water supply options and additional conservation measures, and define a cost-effective and sustainable water supply portfolio. This Master Plan will serve as a guidance document for the City's future growth, with the plan implementation adaptively managed as needed, as SGMA plans and programs become more defined.

ES-1.1 Water System Description

Patterson is located in Stanislaus County on Highway 33, along the Interstate 5 corridor, 280 miles north of Los Angeles, 92 miles south of Sacramento, 89 miles southeast of San Francisco and 45 miles southeast of Livermore. The City is located between Interstate 5 to the west and the San Joaquin River to the east, sloping from southwest to northeast. The City's sphere of influence covers approximately 11.9 square miles.

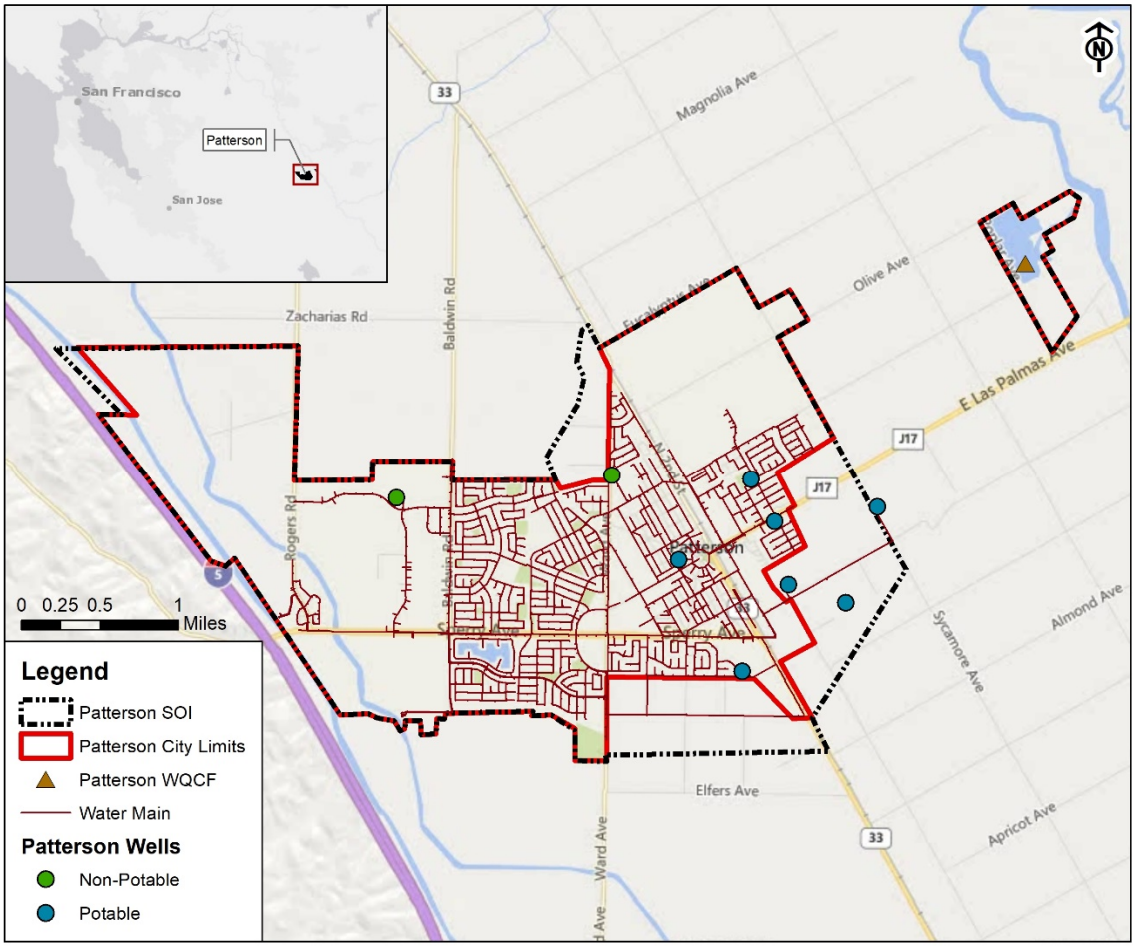
The City relies solely on groundwater—drawn from the Delta-Mendota Subbasin (in the San Joaquin Valley Basin)—for its water supply. Groundwater beneath the City of Patterson is present in two aquifers, a lower confined zone and an upper unconfined zone. The two aquifers are separated by the thick, semi-impermeable Corcoran Clay layer. Potable water is drawn from the lower aquifer, which contains water generally suitable for potable use and requires only disinfection prior to distribution. Water found above the clay layer is extracted for non-potable use, with levels of TDS and nitrate above those acceptable for potable consumption.

The City operates nine water production wells, seven of which are dedicated to potable supply and two for non-potable supply. The City supplies potable groundwater for residential, industrial, and commercial uses through a combination of these wells, storage tanks, and a network of piping. The City's water system includes three storage tanks, 10 booster pumps (at 3 pump stations) and 85 miles of distribution main. In 2008 the City approved a non-potable water program to use lower quality, fit-for-purpose water for irrigation of public and commercial landscaping. A summary of the existing infrastructure is provided in Table ES - 1 and a map of the service area and distribution system is presented in Figure ES - 1.

Table ES - 1: Existing Water Infrastructure

Facility	Quantity
Potable System	
Wells	7 (7,300 gallons per minute (gpm) total capacity)
Pipe	448,600 Linear Feet (LF)
Pumps	10 (at 3 pump stations)
Storage Tanks	3 (3.5 million gallons (MG) total storage)
Customer Meters	6,268
Non-Potable System	
Wells	2 (1,600 gpm total capacity)
Pipe	32,800 LF
Customer Meters	23

Figure ES - 1: City of Patterson Service Area



ES-2 Supply and Demand Analysis

ES-2.1 Demand Forecast

A review of existing City water demands was conducted and used to project future water demands. Existing water demand and land use data was used to develop water use duty factors. These duty factors, consumption per acreage for a given land use type, were then adjusted based on new development standards (such as units per acre) and applied to the future land use to project buildout water demands. A summary of the potable and non-potable demands are presented in Table ES - 2.

Table ES - 2: Potable and Non-Potable Water Demand Summary and Projection Through 2050

	2013	2030	2050
Potable Average Annual Demand (AFY)	3,687	9,390 [1]	14,231
Non-Potable Average Annual Demand (AFY)	270	--	396 [2]
Total Consumption (AFY)	**3,957**	**9,390**	**14,627**
Unaccounted for Water (AFY) [3]	475	766	1,708
Total Demand (AFY)	**4,432**	**10,156**	**16,335**

Notes:
1. Potable average annual demand for 2030 was determined using interpolation from existing to buildout demands.
2. The non-potable average annual demand only account for Phase III of the Non-Potable Water Program. Future non-potable demands will be revised based on anticipated non-potable retrofits. This will be discussed in Chapter 6.
3. The unaccounted-for water is based on 12 percent of the total demand.

ES-2.2 Groundwater Analysis

Though the City currently utilizes groundwater as its sole water source, the passage of SGMA will significantly impact the way groundwater usages in California is managed in the future. The City recognizes the importance of managing resources responsibly and even as its groundwater use represents a small fraction of the pumping in the area, the City has taken an active role in the SGMA process, engaging with neighboring agencies and stakeholders to develop a Groundwater Sustainability Plan (GSP) for the Delta-Mendota Groundwater Basin. Driven by the principle of using groundwater resources responsibly, this Master Plan includes a multipart groundwater analysis scoped and funded prior to the passing of SGMA, to determine the sustainability of continued and/or expanded groundwater usage and the potential for aquifer recharge from percolations ponds. This assessment may need to be revisited and/or expanded on as sustainability programs are developed for the GSP.

ES-2.2.1 Operation Yield

An Operational Yield Study (OYS) was conducted to determine an estimated volume of groundwater that the City could extract from the underlying Delta-Mendota Groundwater Basin without impacting their current groundwater pumping infrastructure and without significantly impacting the use of groundwater resources in the area surrounding the City's Sphere of Influence (SOI). The OYS was conducted using the C2VSim numerical groundwater model for California's Central Valley. C2VSim is an integrated numerical model, vetted and used by DWR, that simulates water movement through the linked land surface, groundwater and surface water flow systems in California's Central Valley. Changes in the City's pumping volume, number of well fields utilized and hydrologic conditions were combined to develop model scenarios in an iterative approach. Table ES - 3 summarizes the different scenarios simulated in the model runs.

Table ES - 3: Summary of Model Scenarios

Scenario	Buildout (2015) Pumping Volume (AFY)	No. of Well Fields Utilized[5]	Model Hydrology[6]
Base AB	4,200[1]	1	Default
Base C	4,200[1]	1	Shifted Critical Drought
1A	24,700[2]	1	Default
1B	24,700[2]	2	Default
1C	24,700[2]	1	Shifted Critical Drought
2A	12,000[3]	1	Default
2B	12,000[3]	2	Default
2C	12,000[3]	1	Shifted Critical Drought
3A	6,000[4]	1	Default
4A	10,000[4]	1	Default

Notes:

1. Assumes pumping value remains constant at 2012 pumping rates (prior to reductions from the drought taking place).
2. Buildout volume from the 2010 Water Supply Analysis. Pumping rates utilized five-year steps to a projection in 2030 and then new step values from 2030 to the buildout value in 2050.
3. Buildout volumes from 2015 RMC demand analysis.
4. Buildout volume selected to try to determine the operational yield with minimal impacts outside City's SOI.
5. If 1 well field is utilized, it is assumed that all pumping will occur in the general vicinity of the existing wells (in the eastern portion of the City). If 2 well fields are utilized, future wells will be constructed in the northwest portion of the City.
6. The default hydrology includes a significant drought event in the middle of the model run. Alternatively, the critical drought was rerun at the end of the model run to line up with the highest pumping rate and reflect a maximum water demand.

Once the C2VSim modeling scenarios were completed, the results were processed and compared to the appropriate baseline results to assess the effects of future Patterson pumping on regional groundwater levels as well as potential impacts to the City's existing production wells. C2VSim produces groundwater elevation data for both above (layer 1) and below (layer 2) the Corcoran Clay.

The following observations can be made about the resulting groundwater level contours:

- The difference in the size (area) of the zone of influence between model runs of pumping from one or two well fields is not significant. This is likely due to the spacing of the wells relative to the size of the C2VSim elements.[1]
- Repeating the 1987-1992 drought at the end of the model run (the highest demand period) does not appear to have a significant impact on the overall pumping impacts.
- The larger the buildout demand, the greater the difference in the drawdown between layer 1 and layer 2. Some of the City's wells are screened across the Corcoran Clay layer as it is represented in C2VSim; that is, the wells 'pump' from both layer 1 and layer 2 in the model. As pumping demands increase, the model appears to increase the contribution of flows from layer 1 to supplement the pumping from layer 2.

[1] A finer grained model scenario may indicate a significant difference between the model runs using one or two well fields.

The following observations can be made about the groundwater hydrographs:

- There does not appear to be any significant impacts on the City's existing wells (evaluated as groundwater levels dropping below the well screen) in any of the model runs.
- The maximum drawdown in both layer 1 and layer 2 for any model run is around 32 feet.

Based on the results of the simulations, a buildout pumping volume of around 10,000 to 12,000 AFY appears to be the groundwater pumping rate that the City can sustain while limiting the pumping zone of influence to the City's SOI.

As this analysis' main purpose was to provide information relevant to mid- and long-term supply planning, it does not assess potential impacts to all potential beneficial uses of water in the area nor does it explicitly look at non-City infrastructure. These type of assessments will be conducted, as part of project implementation phases, as it has been common practice at the City for capital improvements. Additional assessment of potential impacts to the surrounding groundwater levels and infrastructure prior will be conducted to installing new groundwater wells.

ES-2.2.2 Field Investigation and Groundwater Analysis

As part of the analysis of the local groundwater basin, a groundwater study and fieldwork was conducted to determine the recharge feasibility of the local aquifers. The groundwater study built on previous studies of the subsurface geological conditions which indicated a thinning of the Corcoran Clay on the western edge of the City (KSA 2010). The updated analysis conducted as part of this WMP relied on new boring logs and well tests to develop an initial analysis and identify areas to pursue additional borings.

The updated analysis concludes the following:

- Shallow conditions, which are considered important in terms of surficial material that may need to be excavated and could a restricting, indicate potentially favorable conditions (a minimal amount of fine-grained material) primarily north of Zacharias Road, between Raines and Rogers Roads, however they do appear extend to the southwest of the DMC as well.
- The subsurface geologic cross sections include a transition from the Corcoran Clay to a "Corcoran Clay equivalent." This clay layer is present in most of the logs evaluated and indicate the clay pinching out somewhere east of the California Aqueduct. For much of the area, the clay ranges from 25 – 40 feet thick.
- Recharge southwest of the DMC could potentially benefit the lower aquifer.

Based on the conclusions of this study, further field investigation was planned to gather additional information regarding the underlying soil conditions to help identify possible locations for a pilot recharge project. Locations for new borings were selected and a field investigation was completed in July 2017. Results of the new borings indicate the following:

- Confirmation of other borings conducted in the area.
    - There are interfingered layers of clay and silt between sand and gravel leading to Corcoran Clay-equivalent layers to the east.
    - There is more clay to the east, with clay layers thinning to the west near the DMC and California Aqueduct
    - Surface recharge/percolation is possible west of the DMC
- Percolation ponds should be sited as far west as possible, ideally between the DMC and California Aqueduct

Based on these results, a site should be chosen (likely between the DMC and California Aqueduct) to conduct a pilot recharge project to determine specific recharge capacity.

ES-2.3 Supply Options

To determine the preferred source of future potable supply, a comprehensive list of potential, conceptual supply sources was developed. In addition to the expansion of groundwater use, 12 other supply options were explored as possible sources of potable or non-potable supply. Those supply options are briefly described in Table ES - 4 and include a list of required facilities and a preliminary, planning-level cost estimate. For the sake of this plan, it was assumed that any new wells may require Chromium VI treatment and will require TDS reduction (reverse osmosis (RO)). A more comprehensive analysis of the need for Chromium VI treatment, the treatment options and a cost estimate is available in the Chromium VI Feasibility Study included in Appendix A (while there is currently no Maximum Contaminant Level (MCL) dictated by the regulatory agencies, the City has completed a Feasibility Study and will initiate further steps if an MCL is issued in the future). Future fieldwork and analyses will be needed prior to the design and construction of TDS reduction treatment.

ES-2.4 Supply Option Criteria and Analysis

As part of the supply portfolio development, the supply options were evaluated based on a number of criteria and their relative importance. In addition to project cost, supply options were evaluated based on the following criteria:

- Groundwater Sustainability: Assessment of the impacts to the local and regional groundwater sustainability, especially as it relates to requirements established by SGMA.
- Time to Implement: Assessment of the estimates of time to implement all the projects associated with the supply options, including planning, interagency agreements, preliminary design and environmental documentation, permitting, design and construction.
- Environmental constraints and/or impacts: Assessment of the challenges to implement the option without significant impacts to the environment and the mitigation that may be necessary for any impacts
- Regulatory Feasibility: Assessment of the challenges and requirements to obtain all permits required for the supply option, excluding considerations related to SGMA, which are measured in a separate criterion
- Institutional Complexity: Assessment of the level of engagement, participation and cooperation of other agencies in the implementation of the supply option, including obtaining the water

All options were scored under each of the criteria listed above, based on the understanding of the issues and complexities associated with each supply option. The scores for each option were discussed with the City and are presented in Table ES - 5. Scores in the table correspond to a scale where the highest number represents best performance (most sustainable for groundwater use, fastest to implement, fewer environmental concerns, higher regulatory feasibility and lower institutional complexity). The lowest number represents the worse performance (greater strain on groundwater basin, longer time to implement, more environmental concerns, more regulatory issues, more institutional complexity).

Supply options are color coded based on mutually exclusive groups as follows:

- Purple – supply option relies on City wastewater effluent
- Blue – supply option relies on stormwater capture
- Yellow – supply option relies on a water purchase
- Green – supply option relies on conservation

- Orange – supply option relies on groundwater pumping

For example, the City cannot use its wastewater effluent for both non-potable reuse and participation in the North Valley project (colored purple).

Table ES - 4: Supply Options Summary

Supply Option	Supply Option Description	Required Facilities	Yield (AFY)	Capital Cost ($M)[1]	O&M ($ / yr)[1]	Unit Cost ($ / AF)[1]
NVRRWP	Patterson transfers wastewater effluent to the Modesto tertiary treatment plant (Jennings) for additional treatment. That effluent would be transported to the DMC from which the City would treat the water for potable use.	Pump station (2), force main (2), Jennings Treatment Plant O&M, DMC intake, Gravity main, SWTP	5,320	$42.0M	$1.4M	$600
Non-Potable Reuse	Patterson's WQCF is upgraded to include tertiary filtration with the effluent percolated and then extracted for non-potable use.	Tertiary filters, Pump station, force main, infiltration ponds, shallow wells	5,040	$38.6M	$1.3M	$590
Stormwater Recharge	Stormwater from Del Puerto Creek is captured and diverted to recharge ponds for future extraction and use.	Infiltration ponds, Groundwater wells	1,700	$7.8M	$0.33M	$380
Exch SWP (a)	The WQCF is upgraded to produce tertiary treated water which is sent to a State Water Project contractor in exchange (10:9) for SWP water. Water is diverted off the California Aqueduct and treated for potable use.	Tertiary filters, Pump station (2), force main (2), Aqueduct intake, Gravity main, SWTP	4,788	$51.6M	$1.3M	$750
Exch SWP (b)	The WQCF is upgraded to produce tertiary treated water which is sent to a State Water Project contractor in exchange (10:9) for SWP water. Water is diverted off the California Aqueduct and treated before being injected into the aquifer for future extraction and use.	Tertiary filters, Pump station (2), force main, Aqueduct intake, Gravity main, SWTP, Injection wells, Deep wells, Chromium VI treatment, RO treatment	4,788	$144.4M	$6.9M	$2,640
Exch CVP (a)	The WQCF is upgraded to produce tertiary treated water which is sent to a Central Valley Project contractor in exchange (10:9) for CVP water. Water is diverted off the DMC and treated for potable use.	Tertiary filters, Pump station (2), force main (2), Aqueduct intake, Gravity main, SWTP	4,788	$51.1M	$1.3M	$740
Exch CVP (b)	The WQCF is upgraded to produce tertiary treated water which is sent to a Central Valley Project contractor in exchange (10:9) for CVP water. Water is diverted off the DMC and treated before being injected into the aquifer for future extraction and use.	Tertiary filters, Pump station (2), force main, Aqueduct intake, Gravity main, SWTP, Injection wells, Deep wells, Chromium VI treatment, RO treatment	4,788	$143.8M	$7.0M	$2,630

Supply Option	Supply Option Description	Required Facilities	Yield (AFY)	Capital Cost ($M)[1]	O&M ($ / yr)[1]	Unit Cost ($ / AF)[1]
Exch SJR (a)	The WQCF is upgraded to produce tertiary treated water which is sent to a San Joaquin River water user in exchange (10:9) for SJR water. Water is diverted off the SJR and treated for potable use.	Tertiary filters, Pump station, force main, River intake, Gravity main (2), SWTP	4,536	$40.8M	$0.82M	$590
Exch SJR (b)	The WQCF is upgraded to produce tertiary treated water which is sent to a San Joaquin River water user in exchange (10:9) for SJR water. Water is diverted off the SJR and treated before being injected into the aquifer for future extraction and use.	Tertiary filters, Pump station, force main, River intake, Gravity main (2), SWTP, Injection wells, Deep wells, Chromium VI treatment, RO treatment	4,536	$130.3M	$6.4M	$2,540
Direct Potable Reuse	The WQCF is upgraded to produce advance treated water suitable for potable use which is used in Patterson.	Advanced Water Treatment Facility, Pump station, Force main	3,990	$45.3M	$4.8M	$1,500
Long-Term Transfers OID	The City negotiates a long-term contract to purchase water. A contract with Oakdale Irrigation District is used as an example.	Aqueduct intake, Gravity main, SWTP, Pump station, Force main	5,600	$35.2M	$2.2M	$620
Additional Wells	The City installs additional groundwater wells to increase its pumping capacity in the deep aquifer.	Deep wells, Chromium VI treatment, RO treatment	5,600	$93.6M	$6.3M	$1,700
Conservation	The City implements various conservation programs to reduce water use.	N/A	700 – 1,800	$2.7M - $18.8M	-	$200 - $1,050
New Non-Potable Wells	The City installs additional groundwater wells to increase its pumping capacity in the shallow aquifer.	Shallow wells, Pump station, Force main	5,600	$17.2M	$0.68M	$250
Treat and Replenish Shallow Aquifer	The WQCF is upgraded to produce tertiary effluent which is infiltrated to the shallow aquifer. Shallow aquifer water is then pumped and treated for potable use.	Tertiary filters, Pump station (2), Force main (2), Infiltration ponds, Shallow wells, Chromium VI treatment, RO treatment	4,480	$126.5M	$6.9M	$2,600
SJR Exchange (Well Exchange)	The WQCF is upgraded to produce tertiary effluent which sent to a nearby partner for non-potable use. In exchange (at a 10:9 rate) the City will be granted access to pump from the partners deep well for treatment and potable use.	Tertiary filters, Pump station (2), Force main (2), Deep wells, Chromium VI treatment, RO treatment	5,040	$102.7M	$5.8M	$1,910

Notes:
1. Costs are presented in 2016 dollars.

Table ES - 5: Supply Option Criteria Scoring

Name[1]	Groundwater Sustainability Scale: 1 to 5[2,3]	Time to Implement Scale: 1 to 5[2]	Environment Constraints Scale: 1 to 3[2]	Regulatory Feasibility Scale: 1 to 3[2]	Institutional Complexity Scale: 1 to 5[2]
1 North Valley RRWP	3	3	2	1	3
2 Patterson RW for NPR	3	3	2	3	5
3 Stormwater Capture	4	3	2	2	4
4 Exchange with SWP	3	2	2	1	3
5 Exchange with CVP	3	2	2	1	3
6 Exchange with SJR	3	2	2	1	4
7 Patterson DPR	3	1	2	2	4
8 Long-Term Transfer	3	3	2	2	2
9 Increased GW Pumping	1*	5	2	2	4
10 Conservation	3	5	3	3	5
11 New shallow GW for NP	1*	5	3	2	4
12 Treat Shallow Aquifer	1*	5	3	2	4
13 SJR Exchange *(Well Exchange)*	2	3	3	3	4

Notes:

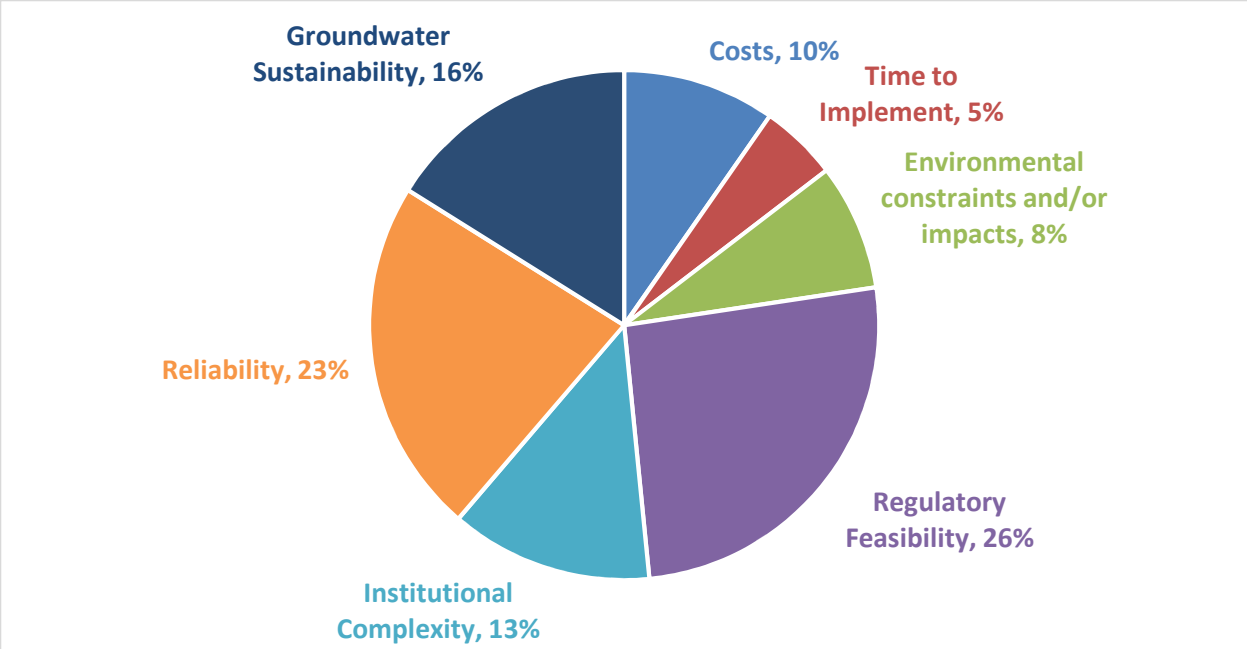
1. Supply options are color coded by mutually exclusive groups:

Relies on Recycled Water	Water Purchase	Groundwater	Conservation	Stormwater

2. Criteria scores – 3, or 5 (see scales) = Best; 1 = Worst
3. **Increased the score to 2 in an alternative ranking sensitivity runs*

Independent of the supply option scores, the City was asked to weight the importance of each criteria relative to the rest. The average response of multiple City representatives is presented in Figure ES - 2. While the cost criterion has a specific weight assigned for the initial ranking of supply options, additional cost considerations have been used in the definition of a feasible and sustainable supply portfolio and the definition of an implementable Capital Improvements Plan (CIP).

Figure ES - 2: Supply Option Criteria Weighting



ES-3 Supply Portfolio Development

ES-3.1 Supply Gap Calculation

Prior to developing supply portfolios, the volume of water that the portfolio must supply—the supply gap—was calculated by subtracting the City's existing and near-term supply capacity from its projected demand. The supply gap was split between non-potable and potable demand to more accurately tailor supply portfolios to the City's needs. Results of that calculation is presented in Table ES - 6.

Table ES - 6: Supply Gap Projections Through 2050

	2020	2025	2030	2035	2040	2045	2050
Potable Average Annual Demand (AFY)	6,139	7,359	8,578	9,798	11,017	12,237	13,456
Baseline Potable Supply (AFY)	5,032	5,032	5,032	5,032	5,032	5,032	5,032
Potable Supply Gap (AFY)	**1,107**	**2,326**	**3,546**	**4,765**	**5,985**	**7,204**	**8,424**
Conservation (AFY)	143	286	429	571	714	857	1,000
Potable Supply Gap after Conservation (AFY)	**964**	**2,041**	**3,117**	**4,194**	**5,271**	**6,347**	**7,424**
Non-Potable Average Annual Demand (AFY)	1,302	1,517	1,731	1,945	2,159	2,374	2,588
Non-Potable Supply (AFY)	1,302	1,302	1,302	1,302	1,302	1,302	1,302
Non-Potable Supply Gap (AFY)	**0**	**214**	**429**	**643**	**857**	**1,071**	**1,286**

ES-3.2 Supply Option Ranking

The scores and weights discussed previously were entered into a decision support tool (Criterium Decision Plus (CDP) software) to rank supply options. To further assess the different supply options and confirm the accuracy of the supply rankings, the CDP software was run for multiple criteria weighting and scoring scenarios to account for sensitivity to criteria scoring and weighting. Ultimately, there was minor sensitivity to changes in weighting and scoring with the various scenarios producing similar results. The supply option rankings for the criteria scoring and weights presented in Table ES-5 and Figure ES - 2 are presented in Figure ES - 3.

ES-3.3 Portfolio Development and Analysis

The supply portfolios were developed using the following approach:

1. Characterize supply options and score and weight them for each criteria.
2. Rank options using the CDP software based upon multiple scoring and weighting scenarios.
3. Define tiers of options based upon CDP rankings.
4. Defined supply gap for potable and non-potable demand. The potable demand did not include system losses and subsequent phases in project implementation will need to define the additional flow from each option or additional conservation levels to account for the small percentage of unaccounted for water in the City's system.
5. Develop portfolios based upon "themes" using supply options from the upper tiers of the rankings. Portfolio "themes" emphasized different traits of supply options that are beneficial for the City.

Themes for the portfolios were developed to emphasize different supply characteristics that are beneficial for the City. The first theme is an emphasis on potable supply, which would ensure that the City could meet any buildout demand in the case that non-potable demands are not able to make the switch off of potable water. The next theme focuses on "Patterson controlled" options, which utilize only supply options which do not require local or regional partners. This theme will greatly reduce the institutional complexity of the portfolio. The final theme is an emphasis on minimizing reliance on groundwater. This theme was developed with pending SGMA regulation in mind as a way for the City to expand its supply portfolio and limit the chance of overdrawing the local groundwater basin.

Each portfolio was developed using options to best fit the supply gap while also aiming to meet the recommendation of the Operation Yield Study and the SB X7-7 per capita water use target. The portfolios are presented in Table ES - 7 through Table ES - 10. A summary of the portfolios including the CDP scores of supply options used, groundwater usage and compliance with the City's SB X7-7 target is presented in Table ES - 11.

Figure ES - 3: Criterium Decision Plus Supply Rankings

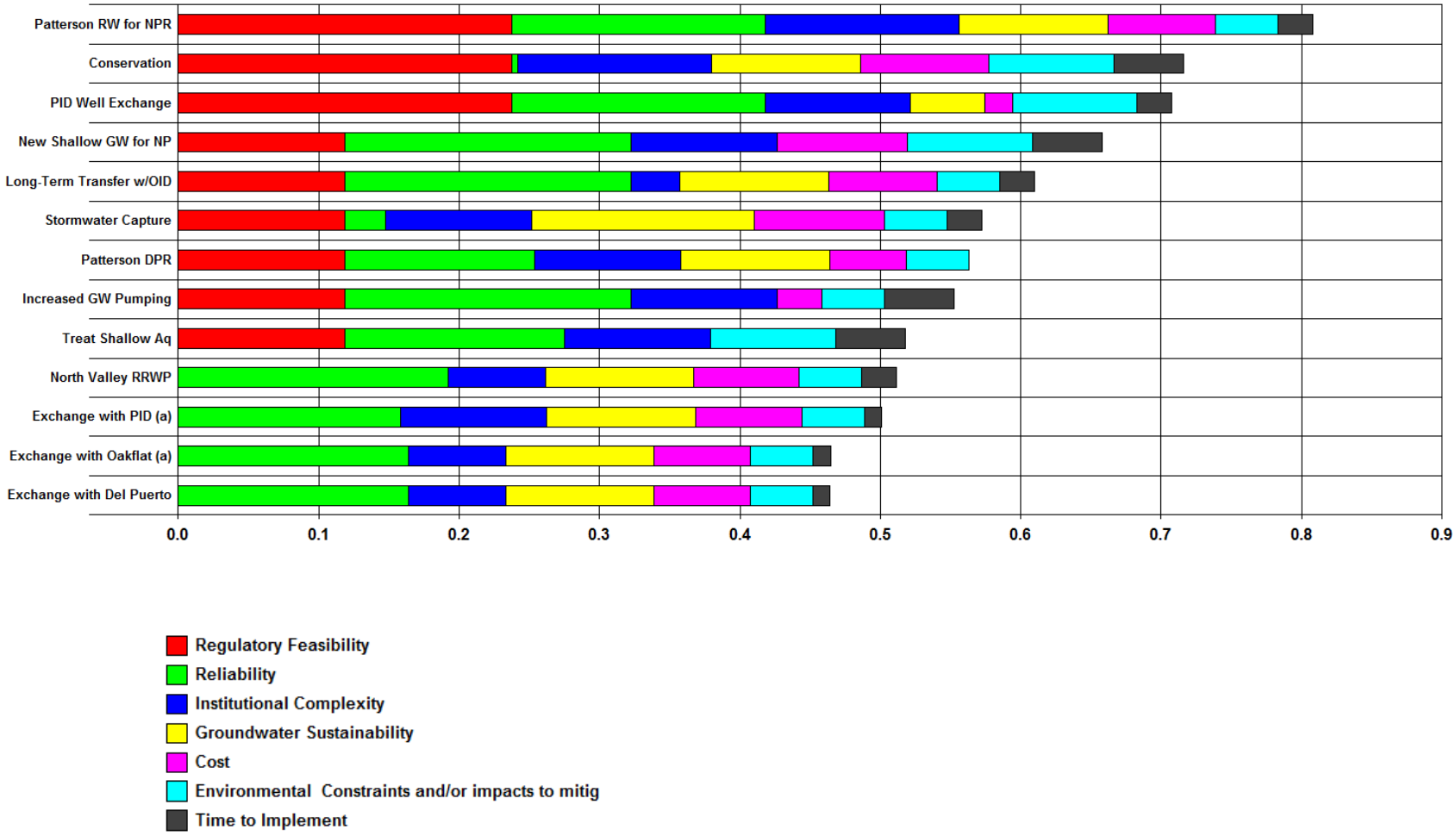


Table ES - 7: Supply Portfolio No. 1 – Potable Emphasis

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 1 (Potable Emphasis)	**9,415**	**$133.9**	**$1,539**
13 SJR Exchange *(Well Exchange)*	5,040	$102.7	$2,124
10 Conservation	1,275	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
9 Increased GW Pumping	1,400	$24.4	$1,701
Total Potable Offset	*1,032*		
Total Groundwater Use for Potable	*8,455*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,802*		

Per Capita Use (gpcd)
181

Table ES - 8: Supply Portfolio No. 2 – Patterson Control

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 2 (Patterson Control)	**9,472**	**$99.0**	**$1,111**
2 Patterson RW for NPR	1,512	$11.6	$585
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
9 Increased GW Pumping	4,480	$79.6	$1,701
Total Potable Offset	*2,544*		
Total Groundwater Use for Potable	*11,815*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Table ES - 9: No. 3 – Low Reliance on Groundwater (1)

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 3 (Less Reliance on GW 1)	**9,472**	**$42.7**	**$519**
8 Long-Term Transfer	4,872	$30.6	$622
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
11 New shallow gw for NP	1,400	$4.3	$247
Total Potable Offset	*2,432*		
Total Groundwater Use for Potable	*7,055*		
Total Groundwater Use for NP	*2,432*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Table ES - 10: Supply Portfolio No. 4 – Low Reliance on Groundwater (2)

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 4 (Less Reliance on GW 2)	**9,472**	**$49.3**	**$569**
8 Long-Term Transfer	4,760	$29.9	$622
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
2 Patterson RW for NPR	1,512	$11.6	$585
Total Potable Offset	*2,544*		
Total Groundwater Use for Potable	*7,055*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Table ES - 11: Portfolio Performance

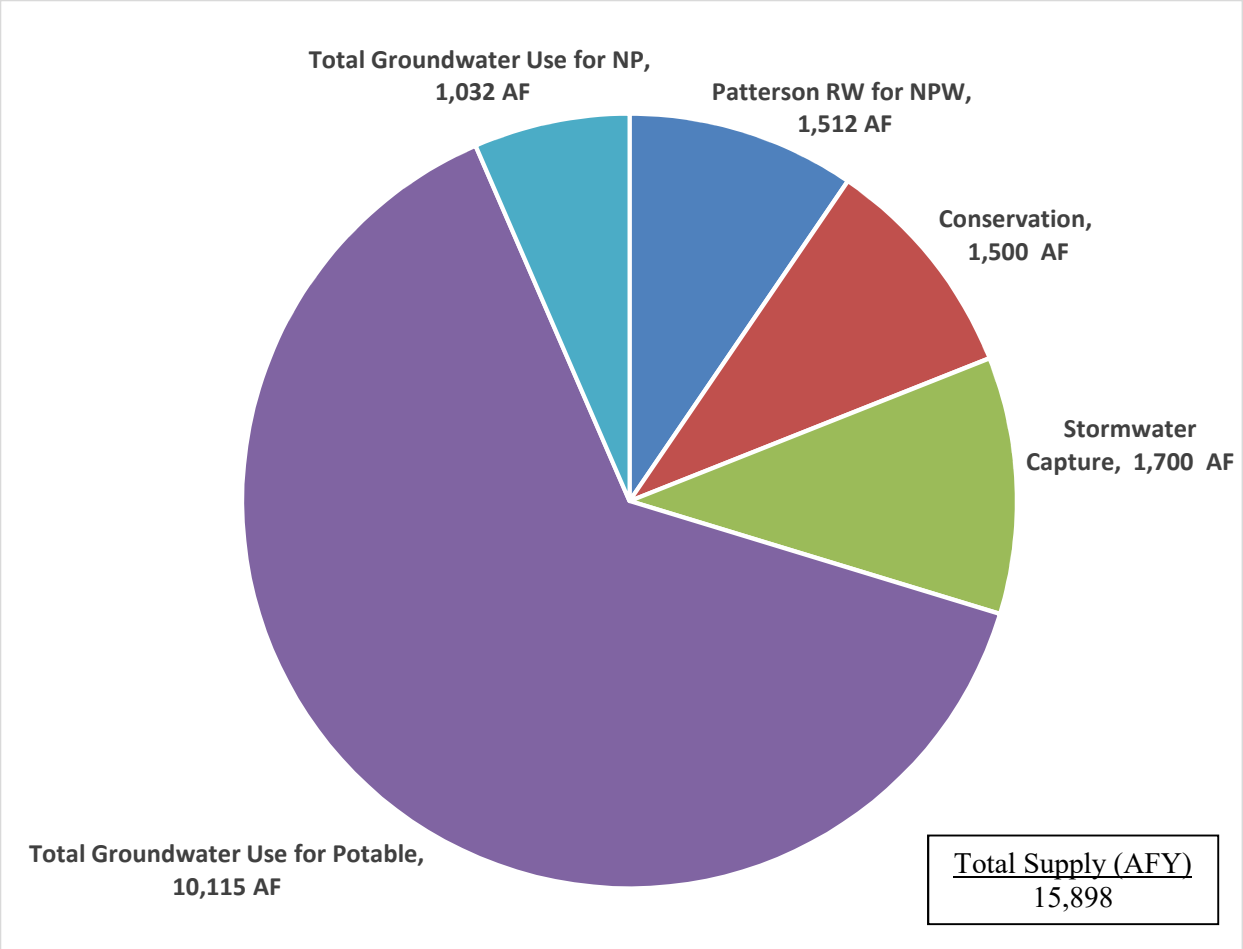
Portfolio		Average CDP Score of Supply Options	Total Groundwater Use (AFY)	SB X7-7 Compliant (2020 Target)	Capital Cost ($M)	Unit Cost ($/AF)
No. 1	Potable Emphasis	0.64	13,925	No	129.2	1,564
No. 2	Patterson Control	0.66	12,245	Yes	94.3	1,121
No. 3	Low Reliance on Groundwater (1)	0.64	9,165	Yes	42.0	513
No. 4	Low Reliance on Groundwater (2)	0.68	7,765	Yes	47.3	567

ES-3.4 Preferred Portfolio

Based upon an analysis of the portfolio performance, two portfolios were recommended: No. 2 – Patterson Control and No. 4 – Low Reliance on Groundwater (2). Portfolio No. 2 was recommended because it offers the City independent control of its water supply and easier implementation of water supply projects. The complexity of partnering with regional agencies has the potential to add additional costs not captured in the estimates of the capital expenditure and operations and maintenance of the supply options. Portfolio No. 4 was recommended as it offers the City the least reliance on groundwater in the face of uncertain SGMA regulation. After deliberation, the City selected Portfolio No. 2 – Patterson Control, as its preferred portfolio. Figure ES - 4 shows the supply mix for the City at buildout demand conditions.

The City recognizes that the selected portfolio may need to be revisited as SGMA-related plans are developed and put into effect or if the predicted yields or feasibility of any projects within the portfolio are determined to be significantly different during additional pre-design analyses.

Figure ES - 4: Supply Mix After Implementation of Preferred Portfolio (Portfolio 2 "Local Control")



Notes:

1. The "Total Groundwater Use for Potable" is equal to the "Total Groundwater Use for Potable" (11,815 AFY) less the volume attributed to "Stormwater Capture" (1,700 AFY).

ES-4 Hydraulic Analysis

ES-4.1 Hydraulic Model Development and Criteria

The City's previous hydraulic model was last updated in 2008 and was never calibrated. For this Master Plan, the model was converted to Innovyze InfoWater™ and updated to include all existing facilities and calibrated per current operations and field investigations.

ES-4.2 Hydraulic Model Assessment

ES-4.2.1 Distribution System Assessment

Using the calibrated existing system network, the model was run to identify existing deficiencies (pressure and velocity) based on the hydraulic criteria. Mitigation projects were developed to relieve those deficiencies and incorporated into the model to create a new baseline system. Using this baseline system, buildout facilities were incorporated for 5-year, 10-year and buildout planning horizons based on development plans and the General Plan. Future pipes were routed along existing roads and likely road

extensions to best serve future development areas. Once the pipe routing was completed wells, tanks and pumps were added to the model.

Per City direction, it was assumed that the distribution system will continue to be served by a combination of ground level storage and variable speed pumps. New wells, tanks and pumps were added to the model with controls to ensure that the various pump stations can operate together to provide adequate delivery pressure. All facilities were sized to meet predicted buildout flows.

ES-4.2.2 Storage Assessment

In parallel to the distribution system assessment, an assessment of the required storage was completed. Using the hydraulic criteria developed with the City, the required storage for each pressure zone was calculated with the total storage requirement equaling the sum of the operational, emergency and fire storage for each zone. Existing storage was calculated based on the existing storage tanks and groundwater storage credit for each existing well. This analysis determined that Zone 1 does not have a storage deficiency while Zone 2 and Subzone 3 have deficiencies of 2 MG and 1 MG, respectively. A summary of the existing system storage analysis is included in Table ES - 12.

Building on the existing system storage assessment, a similar analysis was conducted for future development phases based on the demand projections. Changes to the existing storage for each zone is based on anticipated development of new groundwater wells and the associated groundwater storage credit. This analysis does not account for any tanks that would be built to meet existing storage deficiencies. As shown in Table ES - 12, new water tanks will need to be constructed in each pressure zone to meet storage requirements as the City expands.

Table ES - 12: Storage Assessment Summary

Zone	Max Day Demand (MGD)	Operational Storage Required (MG)[1]	Emergency Storage Required (MG)[2]	Fire Storage Required (MG)[3]	Total Storage Required (MG)	Existing Storage (MG)	GW Storage (MG)[4]	Deficiency (MG)[5]
Existing								
Z1	5.05	1.5	2.5	1.25	5.25	3.5	1.75	0
Z2	1.21	0.25	0.75	1	2	0	0	2
Subzone 3	0.1	0	0	1	1	0	0	1
5-Year								
Z1	6.09	1.75	3	1.25	6	3.5	2	0.5
Z2	1.78	0.5	1	1	2.5	0	0	2.5
Subzone 3	0.14	0	0	1	1	0	0	1
10-Year								
Z1	6.52	1.75	3.25	1.25	6.25	3.5	2	0.75
Z2	2.29	0.75	1.25	1	3	0	0.25	2.75
Subzone 3	0.14	0	0	1	1	0	0	1
Buildout								
Z1	9.62	3	4.75	1.25	9	3.5	2.5	3
Z2	6.34	2	3.25	1.25	6.5	0	1.75	4.75
Subzone 3	0.22	0	0	1	1	0	0	1
New Zone	1.66	0.5	0.75	1	2.25	0	0	2.25

ES-5 Capital Improvement Plan

The CIP was prepared for the City as a guide for project implementation through buildout, specifically over the next 10 years. Projects included in the CIP were developed based on the results of the supply portfolio selection, hydraulic analysis and City staff review of existing facilities. Costs for the projects were prepared at a planning level (-30% to +50% of the final cost) using 2016 dollars.

ES-5.1 New Supply Projects

Based on the preferred supply portfolio, facility projects were developed for the selected future water supplies: new groundwater wells, stormwater capture and tertiary treated recycled water. New groundwater wells are anticipated to be constructed roughly every five years to meet growing City demands. These wells will draw from the sub-Corcoran aquifer and will require chlorine dosing.[2] Each well will have a capacity of roughly 1,500 gpm, providing around 1,000 AFY of potable supply. In addition to new wells, percolation ponds will be constructed as part of the stormwater capture alternative. In total, the ponds are expected to cover roughly 14 acres. The exact siting of each new well and the sizing and location of the stormwater capture will be determined based on future siting and yield analyses and a review of potential impact on surrounding infrastructure and beneficial uses.

The final supply project will be the addition of tertiary filtration to the existing WQCF to produce non-potable effluent suitable for irrigation around the City. The treated effluent will be incorporated into the City's existing non-potable distribution system. This project will provide around 1.4 mgd (1,600 AFY) of non-potable supply for the City. The new supply projects are summarized in Table ES - 13.

Table ES - 13: New Supply Projects

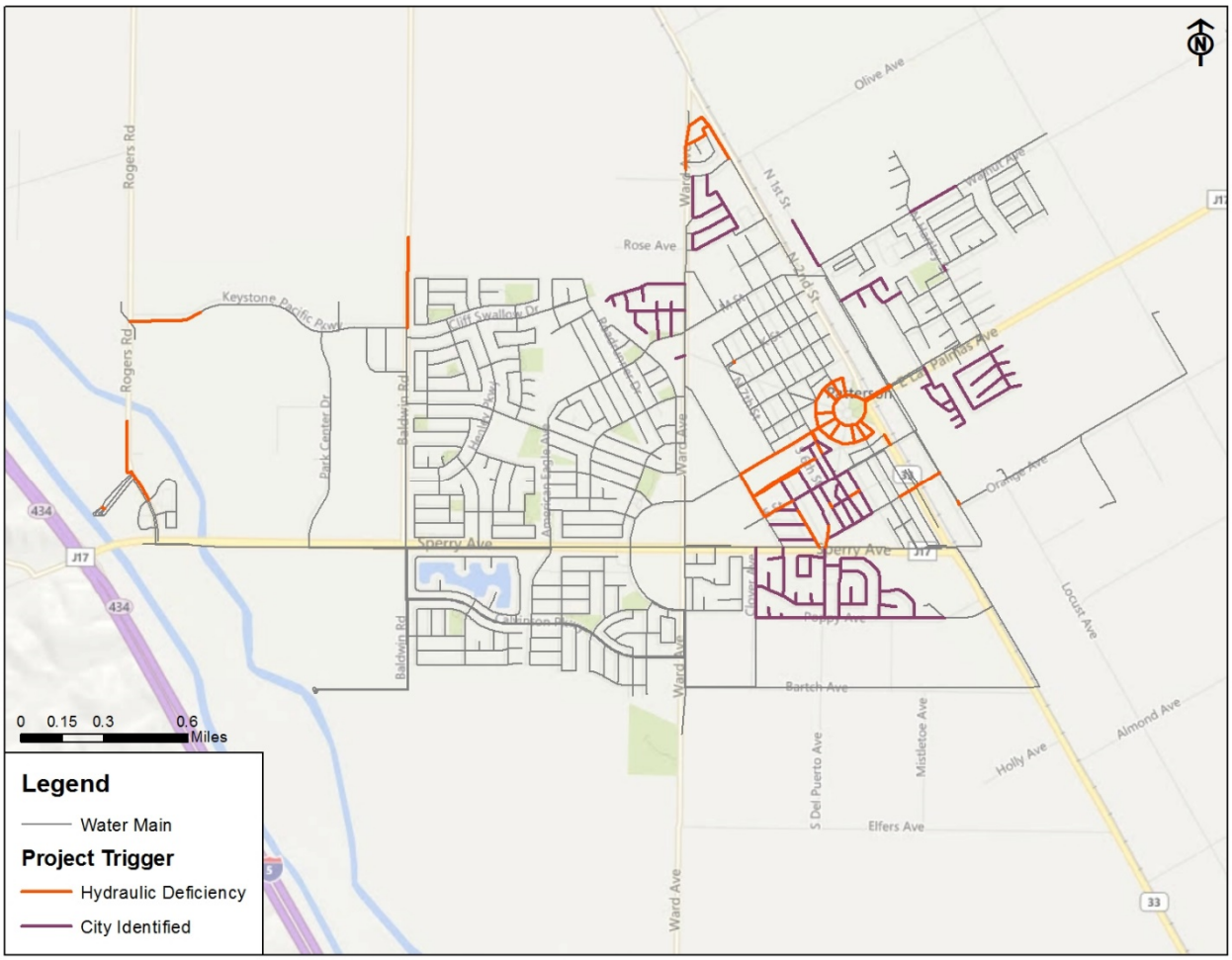
Project ID	Project Phase	Project Description	Cost Estimate (2016 $s)
WL-1	10-year	Develop a new well-field in the northwest of the City and construct one well feeding pressure zone 2. The well is assumed to have a capacity of roughly 1,500 gpm.	$3,062,000
WL-2	Buildout	Construct new well in existing well-field in the eastern portion of the City, serving pressure zone 1. The well is assumed to have a capacity of roughly 1,500 gpm.	$3,062,000
WL-3	Buildout	Construct four new wells in the well-field in the northwest of the City feeding into pressure zone 2. Each well is assumed to have a capacity of roughly 1,500 gpm.	$11,499,000
PP-1	5-year	Construct percolation ponds to capture and infiltrate stormwater from Del Puerto Creek. The ponds will cover roughly 14 acres.	$7,476,000
TT-1	10-year	Add tertiary filtration to the WQCF to produce 1.4 mgd of treated water for non-potable reuse.	$1,951,000
Total			**$27,050,000**

ES-5.2 Existing System Improvement Projects

[2] Pending future MCL regulations, Chromium VI treatment may be required at the well site before distribution. Possible treatment options include reduction-coagulation-filtration, weak base anion exchange, strong base anion exchange and reverse osmosis.

Based on the results of the existing system hydraulic assessment, improvement projects were developed to address the identified deficiencies. These projects address insufficient fire flow and maximum velocity hydraulic triggers. Additionally, City staff identified several projects to replace pipes and service connections nearing the end of their useful life. Existing system improvement projects are shown in Figure ES - 5.

Figure ES - 5: Existing Deficiency Mitigation Projects



ES-5.3 Buildout System Projects

The hydraulic model was used to expand on the existing system to accommodate future development. Development projects were split into three planning phases; 5-year, 10-year and Buildout. While the 5- and 10-year plans could be tailored to detailed development plans, buildout projects were sized based on existing information provided in the General Plan. The demand projections are considered fairly accurate for the buildout timeframe; however, the exact timing and location of all future developments is not currently known. Therefore, the tank sizing is likely accurate, but placeholders for the pump stations, pipes and wells have been used based on information available at this time. Buildout projects will need to be reevaluated as more development plans become available and additional analyses are conducted.

ES-5.4 CIP Summary

The existing, 5-year, 10-year and buildout project lists were combined to create the complete the master CIP program. Though the cost estimates for each individual project were developed using 2016 dollars, the project summary table (Table ES - 14) incorporates inflation to better capture the anticipated project cost and serve as a basis for City rate studies and budgets. The table also includes designations as to whether the project was triggered by existing deficiencies or future system needs. The locations of each project are shown in Figure ES - 6 to Figure ES - 10.

Table ES - 14: Capital Improvement Plan Summary

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
ST-1	4	*Existing Need*	20/21	New 1.0 MG Storage Tank (Zone 3)			$1,870,000											$1,870,000	$1,870,000	$0
ST-2	1	*10-year*	24/25	New 1.25 MG Storage Tank (Zone 2)							$2,654,000							$2,654,000	$0	$2,654,000
WT-1	3	*Maintenance*	19/20	Re-coat Storage Tank (Zone 1)		$348,000												$348,000	$348,000	$0
WT-2	4	*Maintenance*	23/24	Re-coat Storage Tank (Zone 2)						$431,000								$431,000	$431,000	$0
WT-3	4	*Maintenance*	18/19	Re-coat Storage Tank (Zone 3)	$338,000													$338,000	$338,000	$0
WM-ST-0	1	*5-year*	19/20	New pipeline to serve the new Zone 2 (Arambel) tank.		$1,212,000												$1,212,000	$0	$1,212,000
PS-0	1	*5-year*	19/20	Add a pump station to pressure zone 2 at the new Zone 2 (Arambel) tank to meet demand/pressure requirements.		$1,487,000												$1,487,000	$0	$1,487,000
PS-1	1	*10-year*	24/25	Add a pump to pressure zone 2 at the new wellfield tank to meet flow requirements.							$1,724,000							$1,724,000	$0	$1,724,000
WL-1	1	*10-year*	24/25	Construct a new well in the northwest portion of the City serving Zone 2.							$3,656,000							$3,656,000	$0	$3,656,000
PP-1	1	*5-year*	23/24	New percolation ponds to capture and recharge stormwater from Del Puerto Creek.			$100,000	$2,723,000	$2,805,000	$2,789,000								$8,417,000	$0	$8,417,000
WM-1A	3	*Existing Need*	18/19	Replace approximately 6,880 lf of existing pipe with 3,250 lf of 6-inch pipe, 2,320 lf of 8-inch pipe and 1,310 lf of 10-inch pipe and the connecting service lines. Additionally, replaced 20 service lines located along Clover Ave.	$2,210,000													$2,210,000	$2,210,000	$0
WM-1B	3	*Existing Need*	19/20	Replace approximately 10,300 lf of existing pipe with 790 lf of 6-inch pipe, 6,100 lf of		$3,381,000												$3,381,000	$3,381,000	$0

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
				8-inch pipe and 3,380 lf of 10-inch pipe.																
WM-2	2	*Existing Need*	21/22	Replace 4,240 lf of existing pipe with 4-inch. 6-inch, 8-inch, 10-inch, 12-inch and 16-inch pipe				$1,639,000										$1,639,000	$1,068,000	$571,000
WM-3	2	*Existing Need*	20/21	Replace 2,660 lf of existing pipe with 8-inch pipe and replace service lines along additional 2,000 lf of pipe (around 40 additional service lines)			$980,000											$980,000	$980,000	$0
WM-4	2	*Existing Need*	23/24	Replace about 5,000 lf of existing pipe with 2,500 lf of 6-inch pipe and 2,500 lf of 8-inch pipe.						$1,840,000								$1,840,000	$1,840,000	$0
WM-5	2-3	*Existing Need*	18/19	Replace 200 lf of existing 6-inch pipe, upsize 910 lf of pipe to 10-inch and install 120 lf of new 6-inch pipe.	$401,000													$401,000	$401,000	$0
WM-6A	2-3	*Existing Need*	19/20	Replace around 10,180 lf of existing pipe with 4, 6, and 8-inch pipe		$2,825,000												$2,825,000	$2,825,000	$0
WM-6B	3	*Existing Need*	22/23	Replace around 150 service lines along 5,600 lf of existing pipe					$5,811,000									$5,811,000	$5,510,000	$301,000
WM-7	2	*Existing Need*	23/24	Replace 3,050 lf of existing pipe with 6-inch pipe (diameter to be confirmed).						$299,000								$299,000	$299,000	$0
WM-8	2-3	*Existing Need*	35-40	Upsize 1,730 lf of existing pipe with 12-inch pipe and install 70 lf of new 12-inch pipe												$1,197,000		$1,197,000	$1,197,000	$0
WM-9	4	*Existing Need*	25/26	Upsize 1,820 lf of existing pipe with 10-inch main and 740 lf with 12-inch pipe and install 220 lf of new 12-inch main.								$839,000						$839,000	$0	$839,000
WM-10	2	*Existing Need*	28-35	Upsize 1,730 lf of existing pipe with 12-inch pipe and											$1,421,000			$1,421,000	$1,421,000	$0

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
				upsize 1,390 lf with 16-inch pipe.																
WM-11	1-2	*Existing Need*	25/26	Replace around 150 service lines along 5,600 lf of existing pipe								$1,680,000						$1,680,000	$0	$1,680,000
WM-12	2	*5-year*	21/22	Install 810 lf of new 10-inch pipe and 7,740 lf of new 12-inch pipe				$4,559,000										$4,559,000	$0	$4,559,000
WM-13	1	*5-year*	20/21	Install 5,250 lf of new 12-inch pipe.			$1,672,000											$1,672,000	$0	$1,672,000
WM-14	3	*5-year*	21/22	Install 2,710 lf of new 12-inch pipe				$2,578,000										$2,578,000	$0	$2,578,000
WM-15	1	*5-year*	19/20	Install 5,540 lf of new 8-inch and 10,500 lf of new 12-inch pipe		$4,952,000												$4,952,000	$0	$4,952,000
WM-16	1	*5-year*	20/21	Install 4,440 lf of new 8-inch pipe, 7,040 lf of new 12-inch pipe and 2,350 lf of new 16-inch pipe.			$4,074,000											$4,074,000	$0	$4,074,000
WM-17	2	*10-year*	25/26	Install 1,460 lf of new 10-inch pipe								$414,000						$414,000	$0	$414,000
WM-18	1-2	*10-year*	26/27	Install 8,080 lf of new 12-inch pipe									$3,228,000					$3,228,000	$0	$3,228,000
WM-19	2	*10-year*	26/27	Install 6,870 lf of new 12-inch pipe.									$5,015,000					$5,015,000	$0	$5,015,000
WM-20	1, 4	*10-year*	27/28	Install 9,140 lf of new 16-inch pipe										$4,899,000				$4,899,000	$0	$4,899,000
WM-21	1	*10-year*	27/28	Install 9,450 lf of new 12-inch pipe and 670 lf of new 16-inch pipe.										$5,946,000				$5,946,000	$0	$5,946,000
WL-2	3	*Buildout*	28-35	Construct a new well serving Zone 1.											$4,431,000			$4,431,000	$0	$4,431,000
WL-3	1	*Buildout*	28 - After FY 40	Construct 4 new wells in the northwest portion of the City serving Zone 2.											$4,160,000	$4,479,000	$10,384,000	$19,023,000	$0	$19,023,000
ST-BO1	3	*Buildout*	After FY 40	New 3.0 MG Storage Tank (Zone 1)													$7,389,000	$7,389,000	$0	$7,389,000
ST-BO2	4	*Buildout*	After FY 40	New 2.0 MG Storage Tank (Zone 2)													$4,651,000	$4,651,000	$0	$4,651,000
ST-BO3	4	*Buildout*	After FY 40	New 2.25 MG Storage Tank (Zone 4)													$5,333,000	$5,333,000	$0	$5,333,000

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
PS-BO-1	4	*Buildout*	After FY 40	Add a pump to serve the tank in the new pressure zone (Zone 4) in the western hills.													$2,231,000	$2,231,000	$0	$2,231,000
WM-BO	1-4	*Buildout*	28 - After FY 40	Install 234,380 lf of new pipe											$33,389,000	$35,950,000	$41,676,000	$111,015,000	$0	$111,015,000
TT-1	n/a	*10-year*	24/25	Construct a new tertiary filtration system at the WQCF to produce Title 22 compliant recycled water.							$2,330,000							$2,330,000	$0	$2,330,000
NP-1	3	*5-year*	19/20	Install 300 lf of new 6-inch 2,500 lf of new 10-inch non-potable pipe		$832,000												$832,000	$0	$832,000
NP-2	2	*5-year*	20/21	Install 1,060 lf of new 4-inch and 5,900 lf of new 12-inch non-potable pipe			$2,655,000											$2,655,000	$0	$2,655,000
NP-3A	1-4	*Buildout*	35-40	Install 7,550 lf of new 4-inch and 6,770 lf of new 8-inch non-potable pipe												$4,819,000		$4,819,000	$0	$4,819,000
NP-3B	3	*Buildout*	35-40	Install 2,600 lf of new 4-inch non-potable pipe												$809,000		$809,000	$0	$809,000
NP-4	2	*5-year*	22/23	Install 7,590 lf of new 8-inch and 2,630 lf of new 10-inch and 1,200 lf of new 12-inch non-potable pipe.					$5,147,000									$5,147,000	$0	$5,147,000
NP-5	1	*10-year*	23/24	Install 11,290 lf of new 12-inch non-potable pipe						$4,750,000								$4,750,000	$0	$4,750,000
NP-6	2	*10-year*	25/26	Install 7,910 lf of new 12-inch non-potable pipe to connect non-potable system to the WCQF.								$3,476,000						$3,476,000	$0	$3,476,000
Total					**$2,949,000**	**$15,037,000**	**$11,351,000**	**$11,499,000**	**$13,763,000**	**$10,109,000**	**$10,364,000**	**$6,409,000**	**$8,243,000**	**$10,845,000**	**$43,401,000**	**$47,254,000**	**$71,664,000**	**$262,888,000**	**$24,119,000**	**$238,769,000**
Existing Deficiency/Maintenance Total					**$2,949,000**	**$6,554,000**	**$2,850,000**	**$1,068,000**	**$5,510,000**	**$2,570,000**	**$0**	**$0**	**$0**	**$0**	**$1,421,000**	**$1,197,000**	**$0**	**$24,119,000**		

Notes:
1. These costs do not match the detailed cost estimates as this sheet includes a cost escalation factor to account for inflation.
2. Cost to future development is based on the difference in cost between projects addressing existing system deficiencies and those that address the requirements for future system expansion. In those cases where the allocation is greater than 0 but less than 100%, the project includes some pipe replacement upsized to accommodate future demands.

Figure ES - 6: CIP Projects Overview

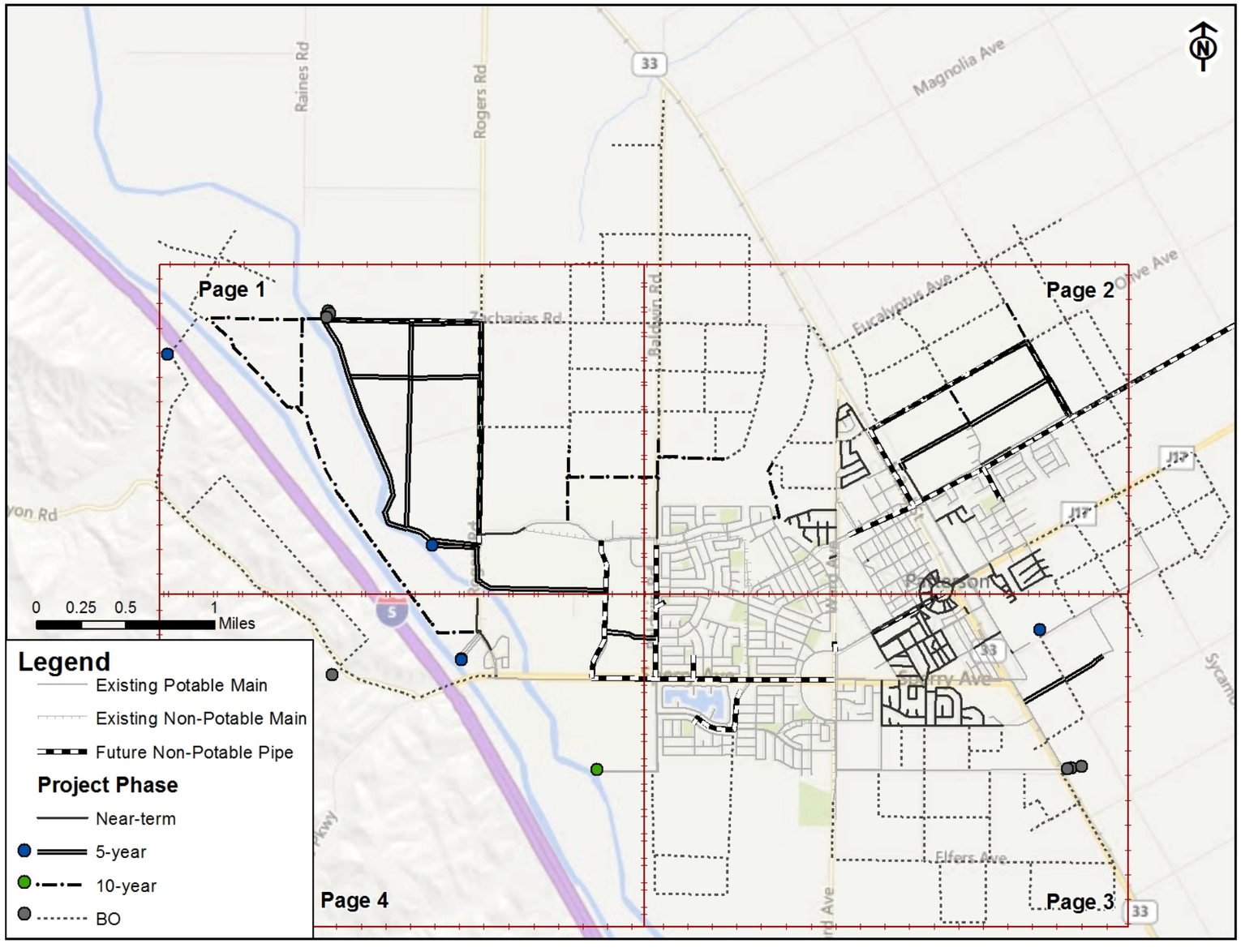


Figure ES - 7: CIP Projects Page 1

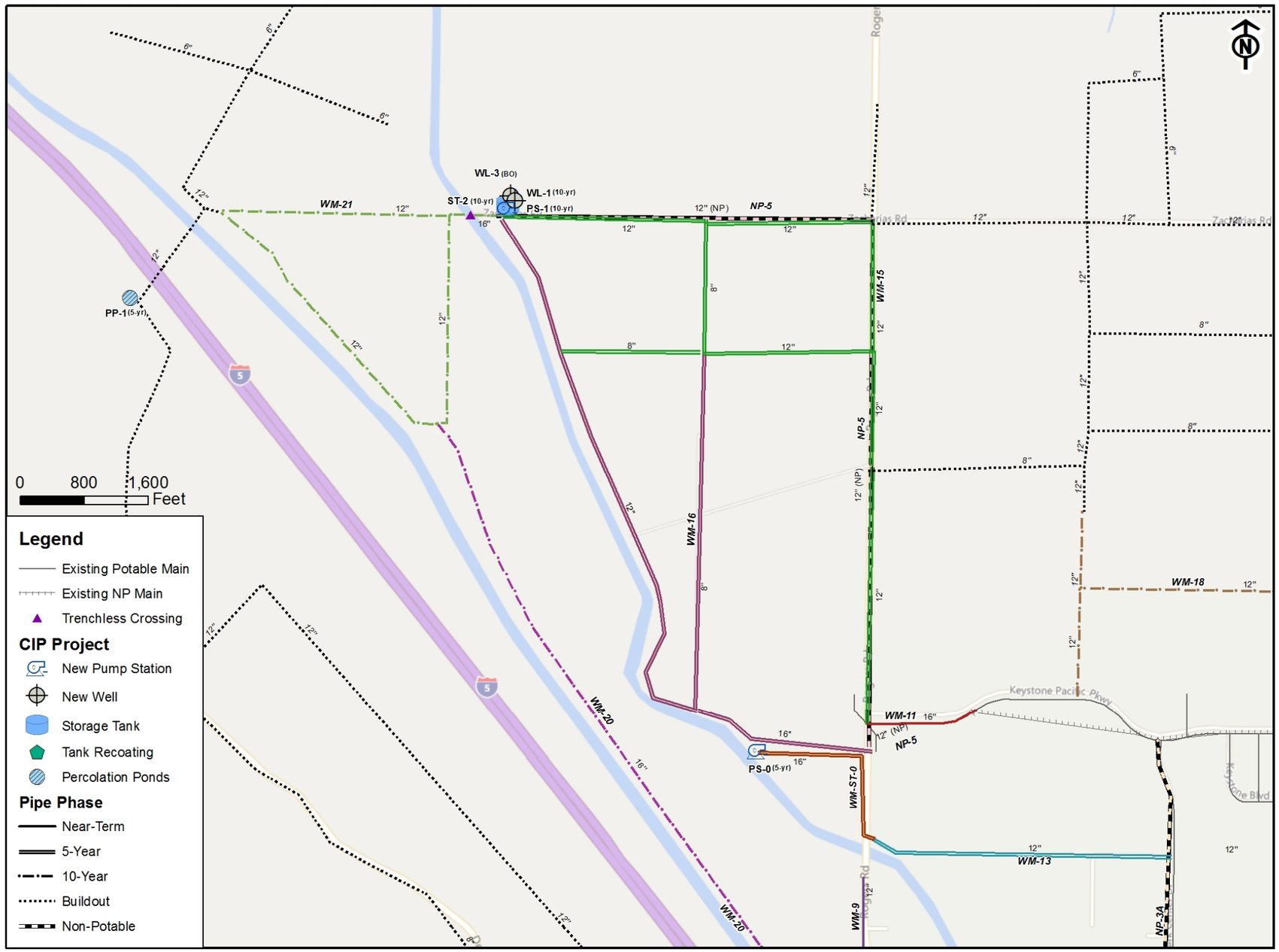
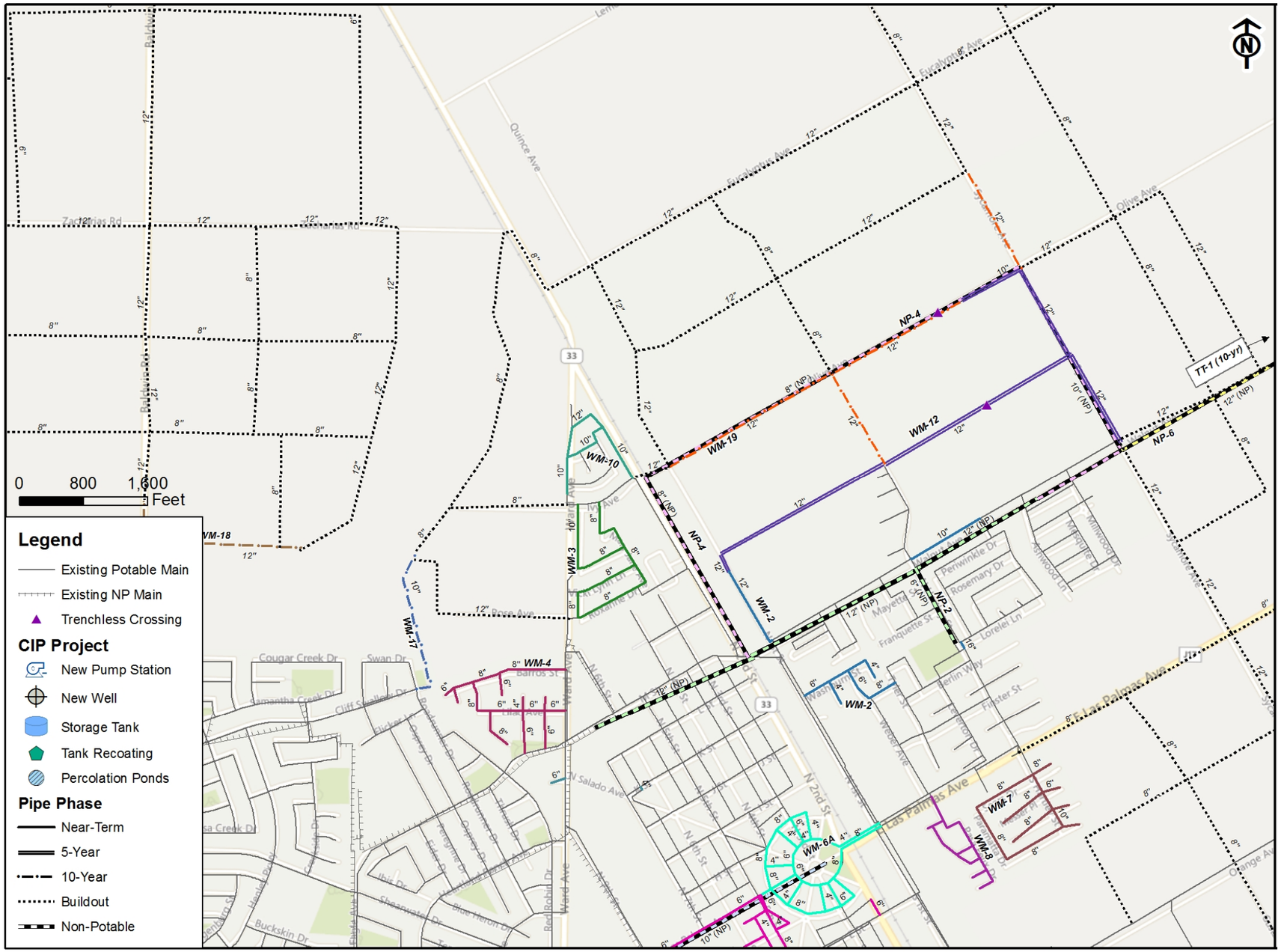


Figure ES - 8: CIP Projects Page 2


0 800 1,600
Feet
Legend
Existing Potable Main
Existing NP Main
Trenchless Crossing
CIP Project
New Pump Station
New Well
Storage Tank
Tank Recoating
Percolation Ponds
Pipe Phase
Near-Term
5-Year
10-Year
Buildout
Non-Potable
Quince Ave
Zacharias Rd
Baldwin Rd
Eucalyptus Ave
Fairbanks Ave
Olive Ave
Las Palmas Ave
E Las Palmas Ave
Orange Ave
Ward Ave
N 2nd St
N 4th St
Keystone Ave
Sycamore Ave
Ivy Ave
Rose Ave
Salado Ave
Barros St
Cougar Creek Dr
Swan Dr
Buckskin Dr
Blue Heron Dr
Periwinkle Dr
Rosemary Dr
Lorelei Ln
Berlin Way
Flipster St
Mayette St
Franquette St
Roxanne Dr
Samantha Creek Dr
Cliff Swallow Dr
Ulva Dr
Shearwater Dr
Ridgeview Dr
Oxbow Dr
Field Dr
Hunter Dr
Hunter Ct
Ward Ct
Ward Pl
Ivy Ct
Ivy Pl
Rose Ct
Rose Pl
Rose Way
Lemon Ave
Penwood Dr
Penwood Ln
Penwood Pl
Penwood Way
Penwood Ct
Mayette Ct
Mayette Pl
Mayette Way
Franquette Ct
Franquette Pl
Franquette Way
Roxanne Ct
Roxanne Pl
Roxanne Way
Lorelei Ct
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Berlin Ct
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Flipster Ct
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Cougar Creek Ct
Cougar Creek Pl
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Swan Ct
Swan Pl
Swan Way
Samantha Creek Ct
Samantha Creek Pl
Samantha Creek Way
Cliff Swallow Ct
Cliff Swallow Pl
Cliff Swallow Way
Ulva Ct
Ulva Pl
Ulva Way
Shearwater Ct
Shearwater Pl
Shearwater Way
Ridgeview Ct
Ridgeview Pl
Ridgeview Way
Oxbow Ct
Oxbow Pl
Oxbow Way
Field Ct
Field Pl
Field Way
Hunter Ct
Hunter Pl
Hunter Way
Ward Ct
Ward Pl
Ward Way
Ivy Ct
Ivy Pl
Ivy Way
Rose Ct
Rose Pl
Rose Way
Lemon Ct
Lemon Pl
Lemon Way
Penwood Ct
Penwood Pl
Penwood Way

Figure ES - 9: CIP Projects Page 3

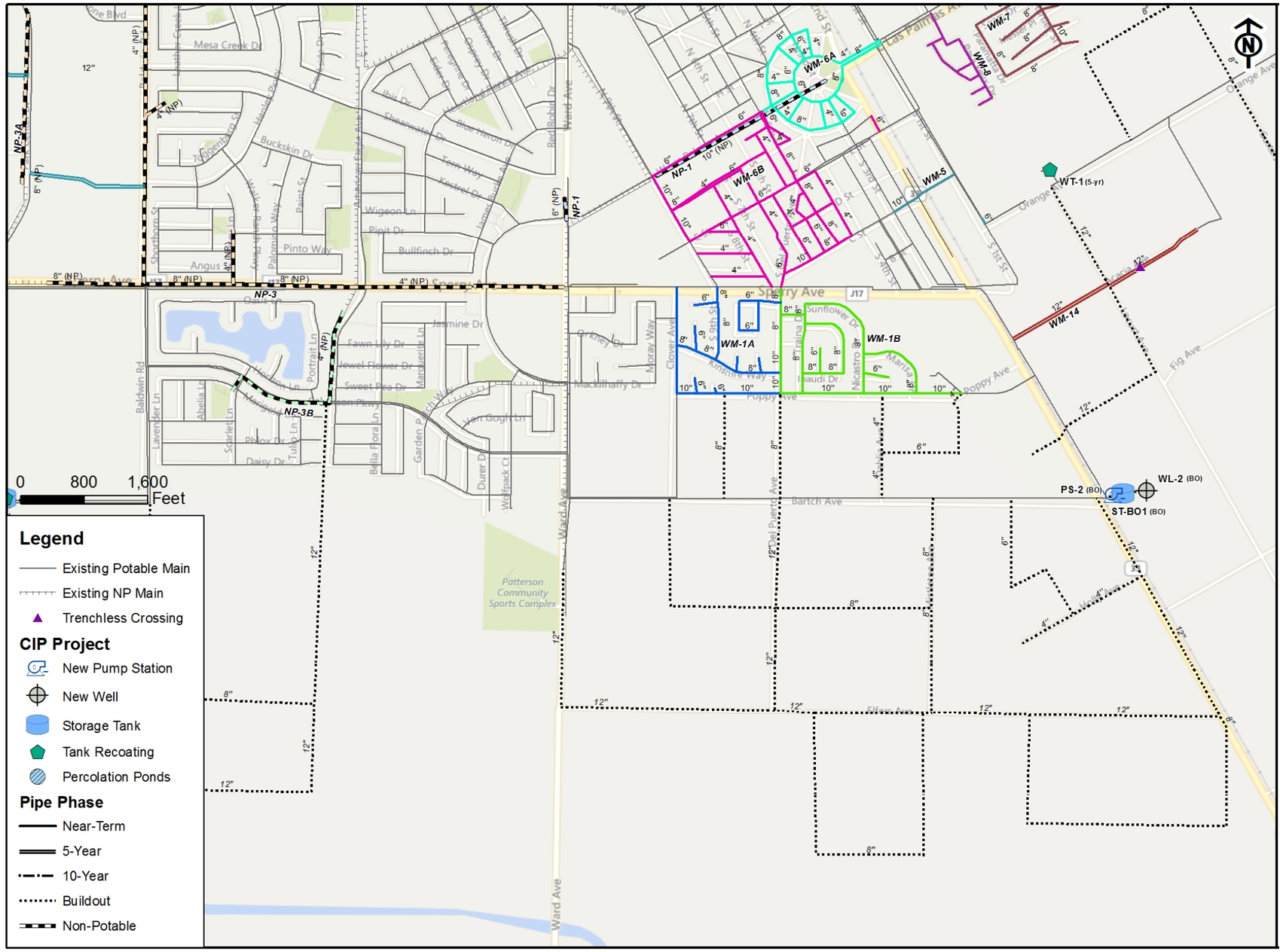
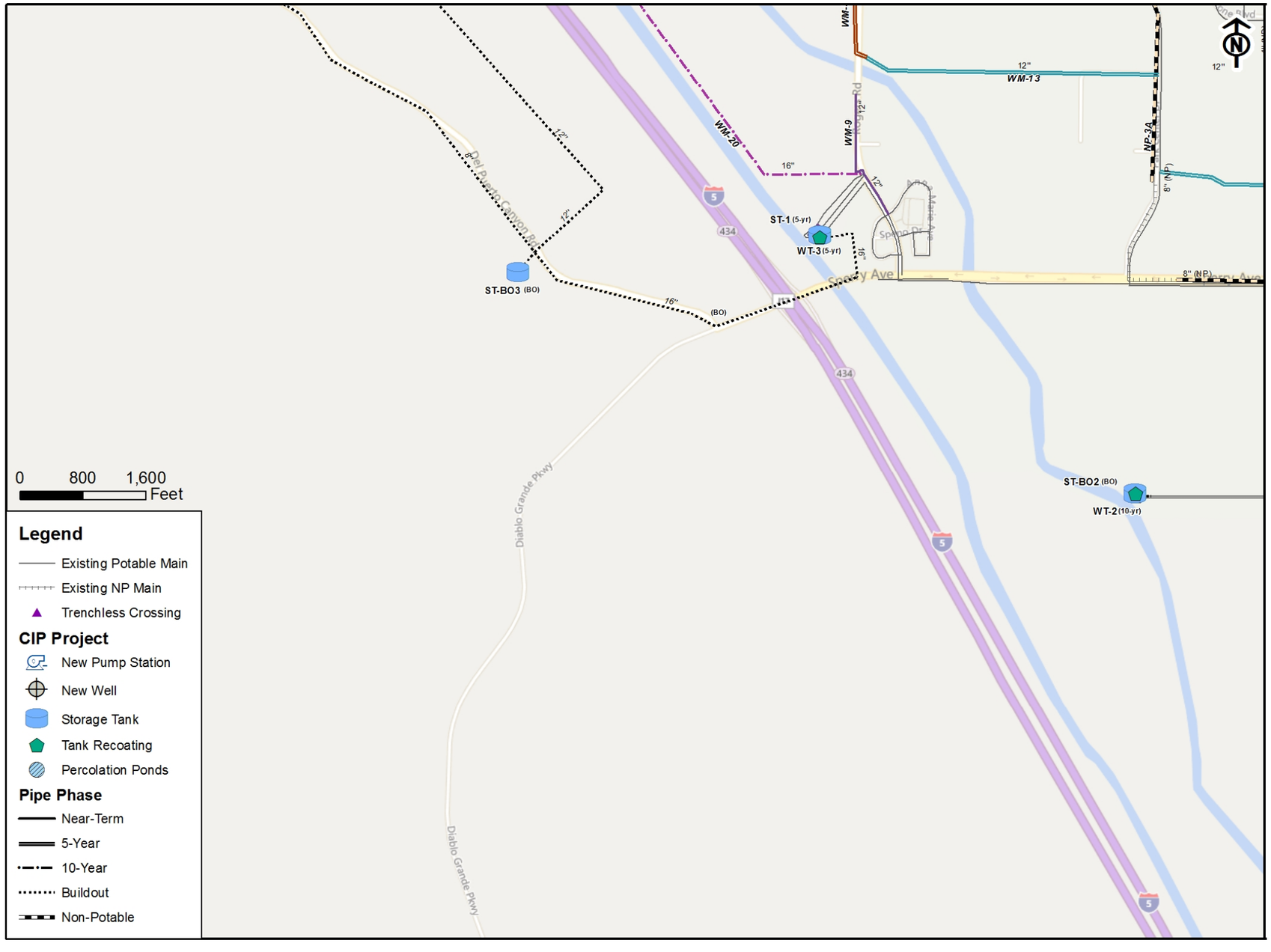


Figure ES - 10: CIP Projects Page 4



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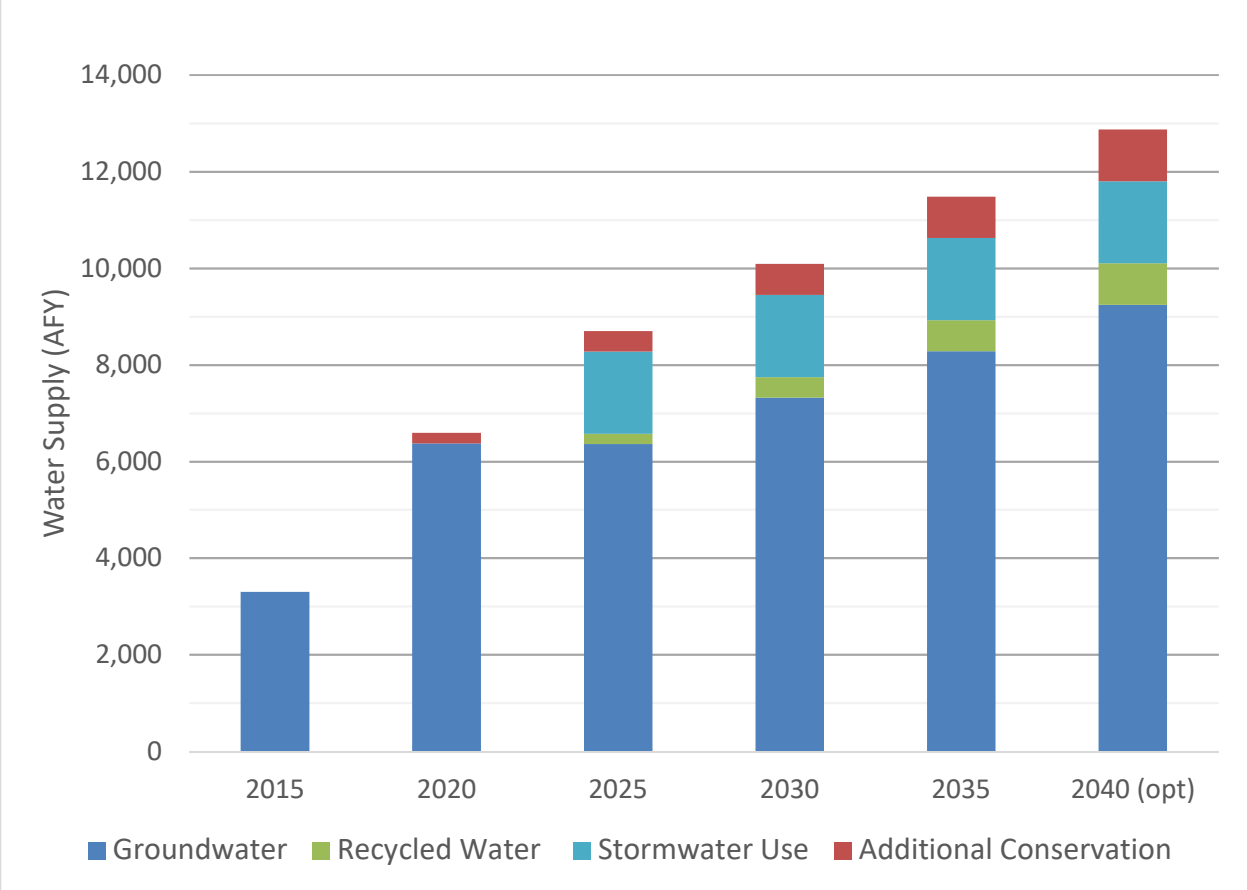
ES-6 Implementation Plan

The water supply portfolio, after full implementation, will provide the supply required under future conditions. The demand evolution from current conditions to build-out conditions, however, allows for phasing in the development of the supply options, and phases within a supply option category (e.g., phasing the construction of new wells for ultimate groundwater development).

Figure ES - 11 shows the gradual introduction of different supply sources in the City's supply portfolio. This introduction of sources over time has been developed under the following criteria:

- Readiness to implement in the short-term
- Certainty about the yield expected by sources
- Required steps in project development (pilot tests, conceptual design, design, permitting, environmental documentation, construction, startup)
- Investment required for project implementation

Figure ES - 11: Implementation of Future Supply Sources



For implementation of the multiple projects required for supply development and conservation programs in the future, multiple funding opportunities will be available. Table ES-15 describes multiple programs that are currently (and in the near future) available for implementation.

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Table ES - 15: Grant Program Overview (*January 10, 2017*)

	Grant Program	Administering Agency	Current Status	Future Timeline	Funding Available Total	Funding Available per Round	Eligible Projects
	California - Proposition 1 Funding						
1	Integrated Regional Water Management	Department of Water Resources	No current open solicitation	Implementation Round 1 PSP expected Spring/Summer 2018 (final PSP in June/July 2018)	$22.5M total for Coachella Valley Region (19.8M remaining)	Varies	Multi-benefit implementation projects that meet objectives of Coachella Valley IRWM Plan
2	Water Use and Efficiency Grants: CalConserve Revolving Fund	Department of Water Resources	Applications accepted on first come first serve basis	None; applications accepted on rolling basis until funds exhausted	$6.75M	$6.75M	$1.75M in loans for water efficiency upgrades. $5M for fixing expensive and difficult to repair customer leaks.
3	Stormwater Grant Program	State Water Resources Control Board	No current open solicitation	Implementation Round 2 tentative for 2018	$200M	$80M	Multi-benefit implementation projects that are included in a Storm Water Resources Plan, respond to climate change, contribute to regional water security, and result in a minimum of 2 quantifiable benefits.
4	Water Storage Investment Program	Water Commission and Department of Water Resources	Applications due by August 14, 2017	Unknown	$2.7B	TBD	Water storage projects that produce real and measurable public benefits, and help address the long-term water needs for California families, farms, communities, and the environment. Must provide measurable benefits to the Delta ecosystem or its tributaries.
5	Water Desalination Grant Program	Department of Water Resources	Final PSP released June 16, 2017	Proposals due September 1, 2017	$100M	$93.1M	Projects that create new or alternative potable water supplies using saline water sources (brackish and seawater)
6	Groundwater Sustainability Program	State Water Resources Control Board	Round 2 pre-application solicitation open. Round 1 awarded 8 projects for a total of $22.8M.	Round 2 is underway on a rolling basis. No deadline or closing date.	$800M	Up to $800M	Projects that address groundwater cleanup or prevent contamination of groundwater that serves as a source of drinking water.
7	Sustainable Groundwater Planning Program	Department of Water Resources	Final PSP released. Applications due November 10, 2017.	Unknown	$100M	$86.3M	Projects that develop and implement sustainable groundwater planning and projects.
	Federal - USBR Funding						
8	Title XVI Feasibility Studies	US Bureau of Reclamation	No current open solicitation	TBD; FOAs typically released in October/November each year	TBD	$1M	Water reclamation and reuse feasibility studies for projects that have been previously authorized for Title XVI.
9	Title XVI Construction Grants	US Bureau of Reclamation	No current open solicitation	TBD; FOAs typically released in October/November each year	TBD	$20M	Construction projects that have been previously authorized for Title XVI.
10	Water Infrastructure Improvements for the Nation (WIIN) - Subset of Title XVI	US Bureau of Reclamation	FOA was released on July 17, 2017. Applications are due on August 17, 2017. Awards to be announced early October.	Next solicitation anticipated in fall 2017.	$50M total	$10M	Construction of water recycling treatment and conveyance facilities for projects that have a Title XVI Feasibility Study completed, but are not congressionally authorized. Assumed that funding terms are similar to Title XVI: Maximum grant award of 25% of the total project costs or $20 million, whichever is less.

	Grant Program	Administering Agency	Current Status	Future Timeline	Funding Available Total	Funding Available per Round	Eligible Projects
11	WaterSMART: Drought Response Program	US Bureau of Reclamation	No current open solicitation	Unknown, though program has had annual funding opportunities since 2015	$4M total	TBD	Planning funding - up to $200k to develop a new drought plan or update existing plan. Project funding - $300k-$750k for projects that increase water reliability, improve water management, implement systems to facilitate voluntary sale, transfer, or exchange of water, and provide benefits to the environment. 50% non-federal cost share required.
12	WaterSMART: Water Marketing	US Bureau of Reclamation	FOA closed on April 19, 2017. Nine projects were awarded $2.1M.	Next solicitation currently unscheduled.	$3M total	TBD	For planning activities to develop a water marketing strategy to establish or expand water markets or water marketing transactions. For planning only - $200k-$400k available for projects that address: outreach and partnership building, scoping and planning, development of a water marketing framework.
13	WaterSMART: Water and Energy Efficiency	US Bureau of Reclamation	No current open solicitation	Next solicitation currently unscheduled	TBD	TBD	$300k-$1M for projects that result in quantifiable and sustained water savings and that may have several components intended to address a significant water management concern (canal lining and piping, installation of water meters, etc.).
14	WaterSMART: Small-Scale Water Efficiency	US Bureau of Reclamation	FOA closed on May 15, 2017. 57 projects were funded a total of $3.6M.	Next solicitation currently unscheduled	Up to $2M	TBD	Up to $75k for new small-scale water efficiency projects that have been identified through previous planning efforts. Eligible projects include installation of flow measurement or automation in a specific part of a water delivery system, lining of a section of a canal to address seepage, small rebate programs that result in reduced residential water use, or other similar projects that are limited in scope.
16	Water Infrastructure Finance and Innovation Act (WIFIA)	US EPA	Selection period from August 1, 2017 - September 29, 2017	Unknown	$1.5B	$45M	Funding for construction of wastewater conveyance and treatment projects, drinking water treatment and distribution projects, desalination, and water recycling projects. Minimum project size for large communities (pop. >25,000) is $25M; for small communities, projects must be at least $5M. Maximum of 49% of the project cost can be financed through the program. Loans are for 25 years or useful life of the project, whichever is less. Non-refundable application fees between $400,000 - $700,000 per applicant.

Chapter 1 Introduction

The City of Patterson (City) is growing and, based on the 2010 General Plan Update, could reach a population of 67,000 (approximately triple the current population) at build-out, with over 50,000 people in 2040. Water demands within the City's service area are currently around 3,300 acre-feet per year (AFY), and expected to rise to around 9,400 AFY within the next 20 years. Currently, potable supplies are reliably provided solely by the City's groundwater well network, coupled with some non-potable sources and significant water efficiency measures in on-going programs by the City. While the approach of using conservation and groundwater to serve new growth can still be a solid component of the City's supply for the future, the water resources landscape in California has significantly changed in recent years.

There is a realization across all sectors in the water industry that significant transformation may be needed in the way California's water is managed. This has been triggered by the recent drought, which is one of the most severe droughts in the State's history, as well as significant legislation that impacts the way we use and supply water. The Sustainable Groundwater Management Act (SGMA) is part of this new context that may impact the City's ability to rely on historical approaches for supply development. With the expected growth, and the new context and restrictions in which new supplies will be developed, the City embarked in a comprehensive Water Master Plan (Master Plan) to rigorously evaluate potential water supply options and additional conservation measures, and define a cost-effective and sustainable water supply portfolio. This Master Plan will serve as a guidance document for the City's future growth, with the plan potentially being revisited as needed as SGMA plans and programs become more defined, and if a Chromium VI MCL is defined for drinking water that requires capital improvements for compliance.

This report includes the following chapters:

Chapter 1 – Introduction

Chapter 2 – Project Background

Chapter 3 – Demand Analysis and Forecast

Chapter 4 – Supply Options

Chapter 5 – Criteria and Supply Analysis

Chapter 6 – Supply Portfolio Development

Chapter 7 – Hydraulic Analysis

Chapter 8 – Capital Improvement Plan

Chapter 9 – Implementation Plan

Chapter 10 – References

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Chapter 2 Project Background

2.1 City Description

In 1909, the Patterson Ranch Company, led by Thomas Patterson, subdivided 18,462 acres into ranches and set in motion the design of the town of Patterson. Determined to make Patterson unique among communities of its size, he modeled his town after the radiating street designs of Washington D.C. and Paris, France, following the design of the famous French architect and engineer Pierre Charles L'Enfant. Major streets were lined with Palm, Eucalyptus and Sycamore trees. The City was incorporated in 1919.

Patterson is located in Stanislaus County on Highway 33, along the Interstate 5 corridor, 280 miles north of Los Angeles, 92 miles south of Sacramento, 89 miles southeast of San Francisco and 45 miles southeast of Livermore. The City is located between Interstate 5 to the west and the San Joaquin River to the east, sloping from southwest to northeast. The City's sphere of influence covers approximately 11.9 square miles. A map of the service area is presented in Figure 2-1.

The City's service area is a mix of residential, commercial, and industrial land use embedded in a rich agricultural area. Since agriculture is the primary economic base, orchards of apricots, almonds and walnuts, as well as row crops of dry beans, tomatoes, broccoli, spinach, peas and melons have and continue to play an important role in the City's prosperity. Further proof of this comes from the City's other name, the "Apricot Capital of the World." The City's current population is roughly 21,000.

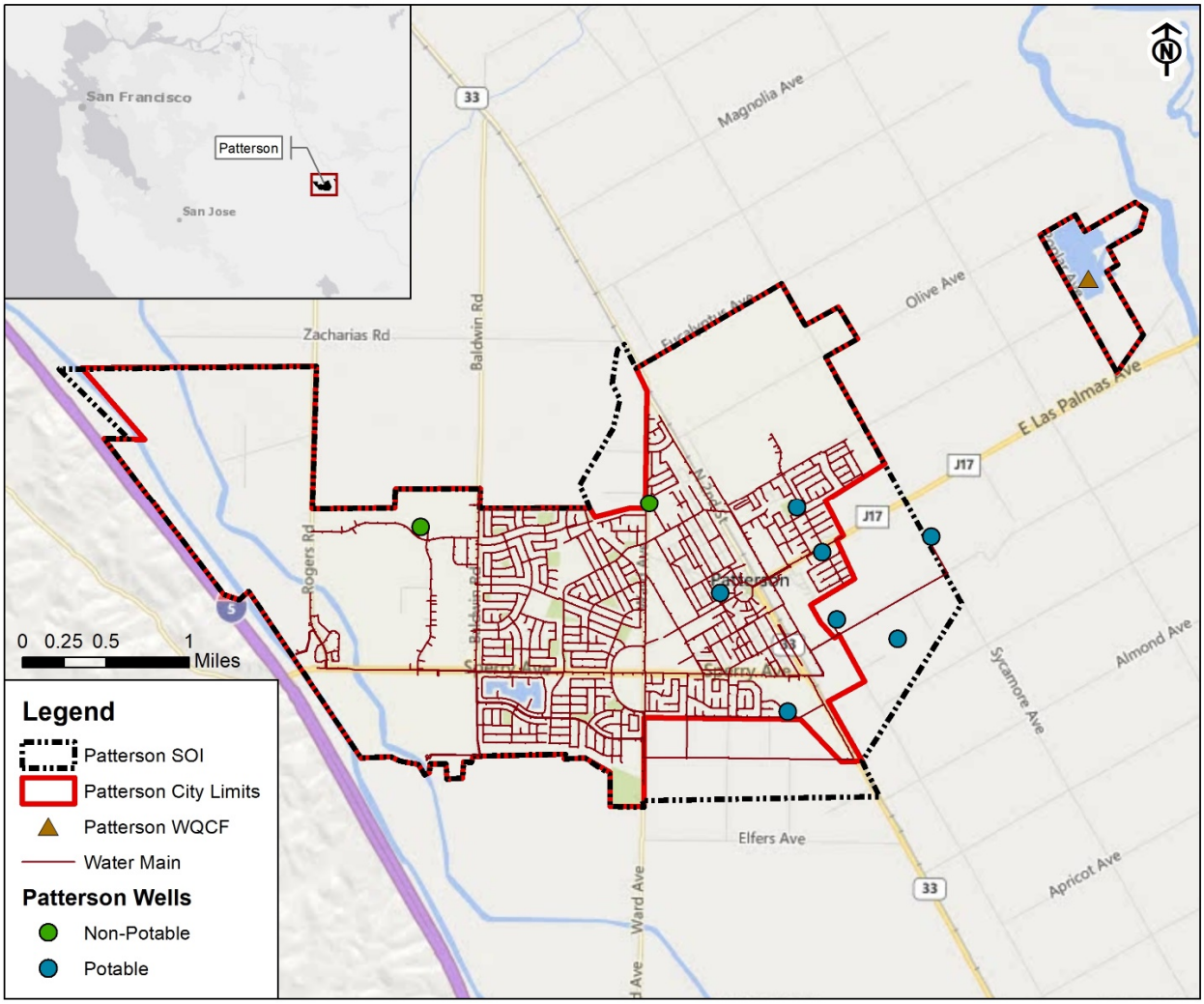
2.2 Water System Description

2.2.1 Water Sources

The City relies solely on groundwater—drawn from the Delta-Mendota Subbasin (in the San Joaquin Valley Basin)—for its water supply. The Delta-Mendota Subbasin is approximately bounded on the west by the Coast Range, on the north by the Stanislaus/San Joaquin County line, on the east by the San Joaquin River and follows the boundary of the Tranquility Irrigation District at its southernmost reach. Groundwater studies of the local basin from 2002 through 2010, conducted by Kenneth D. Schmidt and Associates, Groundwater Consultants (KSA) based in Fresno, California, state: "*Groundwater is present in two aquifers beneath the City of Patterson …water levels in both aquifers have apparently been relatively stable of the long term"* (KSA, 2010). The studies concluded that there are essentially two aquifers underlying the City; a lower confined zone, and an upper unconfined zone. The two aquifers are separated by the thick, semi-impermeable Corcoran Clay layer. Much of the Subbasin includes the Corcoran Clay formation, which underlies the basin at depths of about 100 to 500 feet and acts as a confining bed. The aquifers are generally quite thick in the San Joaquin Valley sub-basins, with groundwater wells commonly extending to depths of up to 800 feet to tap into the sub-Corcoran aquifer. A map of the Subbasin can be found in Figure 2-2. KSA estimated that natural inflows to the two basins are approximately 3,500 AFY (upper) and 8,900 AFY (lower), based on basin hydraulic conductivity, transmissivity, and gradients. Additional recharge to the upper aquifer is expected from canal seepage, percolation of applied irrigation water, and stream flow seepage. Hence, total inflow to the local basin underlying the City is upwards of 12,500 AFY (KSA, 2010). As part of this WMP, an Operational Yield Assessment was conducted to further evaluate the City's available groundwater supply. This assessment is presented in Section 4.1.1.

As part of this WMP, the City evaluated supply options (discussed in Chapter 4) relying on water from the Delta-Mendota Canal (DMC), California Aqueduct, San Joaquin River, stormwater and recycled water. While recycled water would be used to meet non-potable demands in the City, the other four potential supply options could be used to meet potable demand.

Figure 2-1: City of Patterson Service Area



2.2.2 Water Quality

Water quality of the groundwater and surface water sources was evaluated for compliance with state and federal regulations and to establish a basis for which potential treatment options could be developed. Water quality above the clay (reachable within about 25 feet of the land surface) is suitable for non-potable use, though recent monitoring suggests that total dissolved solids (TDS) and Nitrate levels are on the rise. Water quality below the clay is generally suitable for potable use with the only treatment requirement being chlorination. However, there have been some monitored instances of high TDS and Chromium VI levels. Chromium VI levels in the Subbasin are compliant with State and Federal regulations, however the California Department of Public Health (now the Division of Drinking Water) recommended implementing stricter standards in 2014 (reducing the acceptable limit from 50 micrograms per liter to 10 micrograms per liter). While a 10 microgram limit is not in place, it is likely that the acceptable limit will be reduced from its current limit of 50 micrograms. The City has coordinated with the Division of Drinking Water and prepared a Corrective Action Plan to address Chromium VI levels in its potable water should a stricter limit be implemented by the Division of Drinking Water. Additional information on the City's plan to address

Chromium VI can be found in the Chromium VI Feasibility Study, prepared concurrently with this WMP, included in Appendix A.

While these supply sources are not monitored for all constituents regulated by the Environmental Protection Agency's (EPA) drinking water standard, they do meet all the requirements for which they are tested, aside from Nitrate, which runs above the standard in the San Joaquin River. That said, all of these sources would require treatment aside from chlorination in order to serve potable demands. A summary of the raw water quality of each supply source is presented in Table 2-1.

2.2.3 Water Supply Balance

While the City has seen steady growth in recent years, it has not seen a large spike in water use. Aside from the effects of the drought, the reason water use lags behind population growth is that the City has an effective water conservation program. The City meters all of its services, and, due to the litigation between other agencies and their customers, have transitioned to a two-tier increasing rate schedule to encourage efficient water use and emphasize the improvement of the City's infrastructure. The City has ordinances in place to discourage water waste, including odd-even watering, and penalties for irrigation "run-off." Started in 2008, the City has a program in place to replace its oldest water pipes with the highest frequency of leaks and repairs, in order to curb water loss. The City's 2015 daily per capita water use number was 135 gpcd and it is well below the City's 2020 target (164 gpcd) under the SBx7-7 legislation (known as the "20 by 2020" mandate), which requires the City to reduce per capita demands by 20% in the year 2020, according to a past usage baseline. While some usage bounce expected after the 2013-2015 drought, it is expected that the City will be in compliance in 2020.

Since the City currently relies on groundwater from the Delta-Mendota Subbasin for its water supply and this subbasin has been characterized as critically overdraft by DWR, groundwater must be properly managed to ensure a sustainable supply of water. Historically, the City has been able to reliably supply its customers and studies described later in this report (Section 4.1) show that groundwater can continue to be a reliable and sustainable supply.

Figure 2-2: Delta-Mendota Subbasin

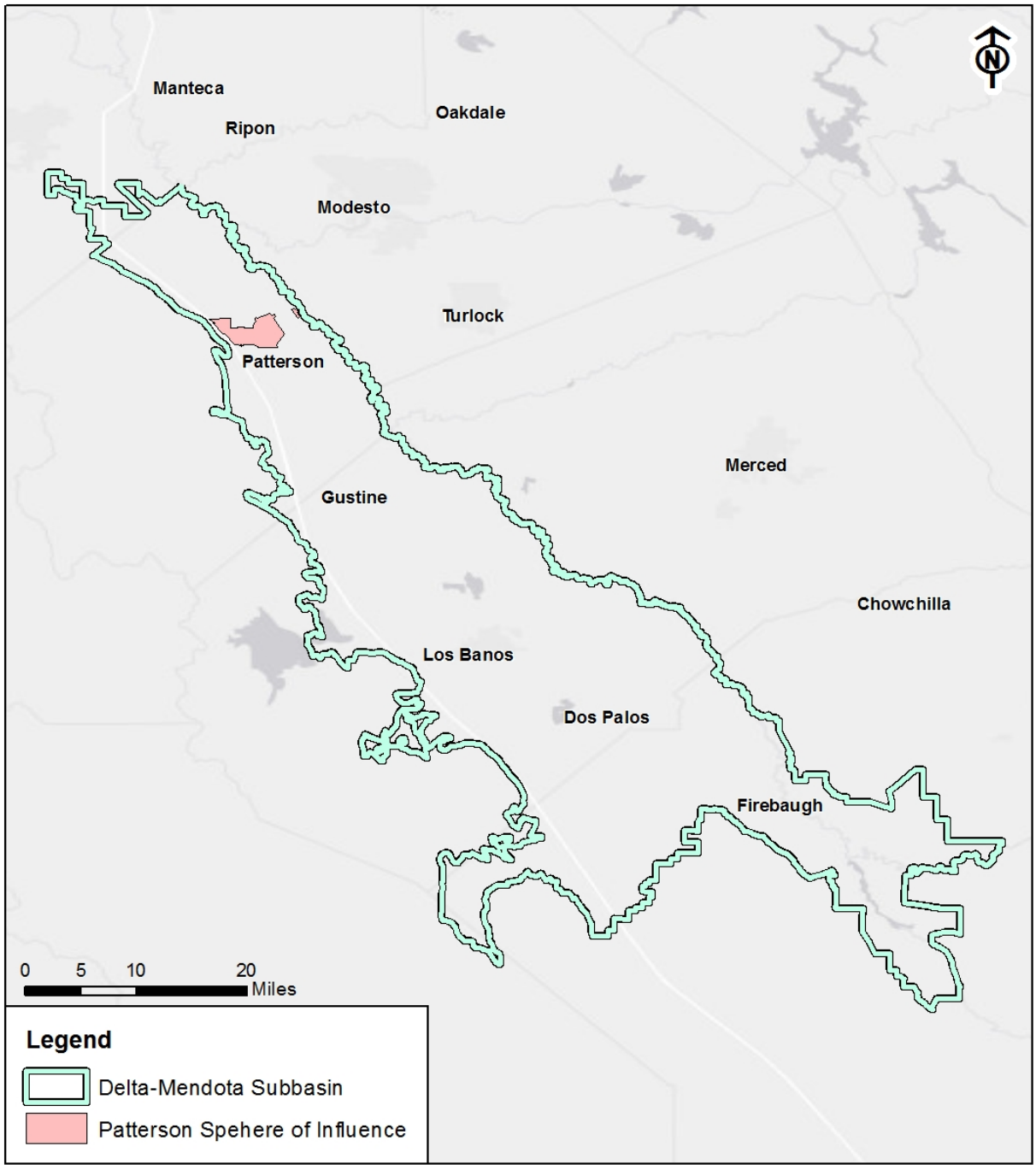


Table 2-1: Raw Water Quality of Supply Sources

Water Source	Drinking Water Standard	Deep Aquifer			Shallow Aquifer			Delta-Mendota Canal		California Aqueduct		San Joaquin River near Patterson		Recycled Water Quality (Jennings)	
Chemical or Constituent [reporting units]			Range	Below MCL		Range	Below MCL		Below MCL		Below MCL		Below MCL		Below MCL
Primary															
Lead [ppb]	15	0.6		Yes											
Copper [ppm]	1.3	0.07		Yes								0.003	Yes	0.003	Yes
Aluminum [ppm]	1	0.017	ND - 0.12	Yes											
Arsenic [ppb]	10	2.9	ND - 5	Yes				5	Yes			4	Yes	3	Yes
Fluoride [ppm]	2	0.1	ND - 0.3	Yes											
Nickel [ppb]	100	2	ND - 20	Yes											
Nitrate [ppm]	45	16.9	ND - 36	Yes	25	5.8 - 93	Yes	6.2	Yes	1.1	Yes	58.9	No	37.2	Yes
Nitrate + Nitrite as N [ppm]	10	2.9	0.7 - 7.6	Yes	5.7	1.3 - 21	Yes					13.5	No	8.6	Yes
Selenium [ppb]	50	4.3	ND - 9	Yes				0.8	Yes			1.9	Yes	0.7	Yes
Gross Alpha [pCi/L]	15	3.1	ND - 5	Yes								--	Yes	--	Yes
Uranium [pCi/L]	20	2.1	ND - 7	Yes											
Secondary															
Chloride [ppm]	500	113	32 - 251	Yes	360	190 - 480	Yes			132	Yes	126	Yes	152	Yes
Color (Unfiltered) [units]	15	3	ND - 9	Yes											
Iron [ppb]	300	70	ND - 300	Yes								--	Yes	0.1	Yes
Specific Conductance [Umhos/cm]	1600	1150	709 - 1460	Yes				419	Yes	664	Yes	1035	Yes	945	Yes
Sulfate [ppm]	500	259	162 - 390	Yes				40	Yes	53	Yes	162	Yes	61	Yes
TDS [ppm]	1000	752	460 - 980	Yes	1580	1200 - 2100	No	275	Yes			679	Yes	551	Yes
Microbiological															
Total Coliform	more than one sample w/detection in a month (MCL)				a few samples with 2/100ml										
Fecal Coliform or *E. coli*															
Other															
Boron	1	0.4	0.3 - 0.6	Yes				0.19	Yes			0.59	Yes	0.2	Yes
TTHM [ppb]	80	0	ND - 0.7	Yes										0.003	Yes
Chromium [ppb]	10	19	20 - 20	No								3	Yes	1	Yes
Reference															
	EPA *(with Cr(VI) standard set to CA limit)*	City of Patterson Consumer Confidence Report (2013)			City of Patterson Quarterly Monitoring Report (2009)			DWR California Data Exchange Center covering 2003-13		DWR California Data Exchange Center (Aug 2014)		From CEDEN (Ceden.org) covering 1995-2012		From July 2011 - Dec 2012 provided by City of Modesto	

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2.2.4 Water Infrastructure

The City operates nine water production wells, seven of which are dedicated to potable supply and two for non-potable supply. Additionally, the City is currently working on developing a new potable well (Well 8). The City's existing potable well field is located in the eastern portion of the City between East Las Palmas Avenue, South 2nd Street and the Patterson Irrigation District Canal. The City supplies potable groundwater for residential, industrial, and commercial uses through a combination of these wells, storage tanks, and a network of piping. The potable well facilities include a chlorine dosing system prior to distribution for disinfection. Each water service is equipped with a water meter for accounting and billing. The City is responsible for operation and maintenance of the water system up to the water meter. The City's water system includes three storage tanks, 10 booster pumps (at 3 pump stations) and 85 miles of distribution main.

In 2008 the City approved a non-potable water program to use lower quality, fit-for-purpose water for irrigation of public and commercial landscaping. Similar to other California cities, public and commercial landscaping is estimated to account for as much as 25% of the City's total annual water use, and over 40% of the peak month demands. The City's Non-Potable Water Program (NPWP) is ongoing. The NPWP is currently using lower quality groundwater (pulled from the upper aquifer) for irrigation, but is being designed and constructed to receive recycled/reclaimed water at some point in the future. Currently, the City's two non-potable wells serve roughly 930 AFY via a network of about 6.2 miles of pipe. This system irrigates some of the City's largest landscapes, reducing the strain on the lower aquifer.

A summary of the existing infrastructure is provided in Table 2-2 and a summary of the existing groundwater wells is presented in Table 2-3.

Table 2-2: Existing Water Infrastructure

Facility	Quantity
Potable System	
Wells	7 (7,300 gallons per minute (gpm) total capacity)
Pipe	448,600 Linear Feet (LF)
Pumps	10 (at 3 pump stations)
Storage Tanks	3 (3.5 million gallons (MG) total storage)
Customer Meters[1]	6,268
Non-Potable System	
Wells	2 (1,600 gpm total capacity)
Pipe	32,800 LF
Customer Meters[1]	23

Notes:

1. The City meters all its water (potable and non-potable) services. The number of meters includes City-owned and private facilities.

Table 2-3: Existing Groundwater Wells

Well No.	Capacity (gpm)	Potable/Non-Potable
2	800	Potable
4	900	Non-Potable
5	1400	Potable
6	600	Potable
7	1500	Potable
8	1000	Potable
9	800	Potable
11	1200	Potable
Keystone	700	Non-Potable
14	800	Potable (Planned)

2.2.5 Wastewater Infrastructure

The City collects and treats its own wastewater at the Water Quality Control Facility (WQCF), located to the east of the City, just north of East Las Palmas Avenue on Poplar Avenue and adjacent to the San Joaquin River. The City's wastewater system receives an average daily flow of around 1.5 mgd. Patterson's treated effluent is discharged to adjacent percolation ponds. The facility treats wastewater to secondary standards and no reuse is currently in place.

Chapter 3 Demand Analysis and Forecast

As part of the master planning effort, a review of existing City water demands was conducted to analyze the existing land and water demand conditions, and project future water demands. This chapter presents the demand analysis and projection through 2050 for the City's Sphere of Influence (SOI).

3.1 Data

RMC worked with City staff to identify existing planning documents used as the basis for existing demand analysis and forecast. The following information was reviewed and used on the analyses and projections of demands:

- **Water Consumption Data by Account Number**: Monthly water usage in hundred cubic feet (HCF) was provided for each account number for the years 2011 through 2013. The individual account numbers were associated with one of the City's four class codes: commercial, irrigation, multi-family or residential.
- **Account Number and Tax Lot Spreadsheet**: This spreadsheet complemented the water consumption data by correlating the account numbers with an eleven digit Tax Lot Number. Not all accounts had a Tax Lot Number associated with it; however, a Tax Lot Number can be associated with multiple account numbers.
- **Existing and Future Non-Potable Accounts Spreadsheet**: This spreadsheet provided a list of existing and proposed non-potable account numbers with their Tax Lot number. The proposed non-potable account numbers are non-potable accounts identified as Phase III of the City's Non-Potable Water Program.
- **Current and Build-out Land Use GIS shapefiles**: The GIS files contained one existing and two buildout (Zoning and TAZ Land Use) shapefiles with land use information. Each shapefile had a nine digit Assessor Parcel Number (APN) associated with all the parcels.
- Reference Documents and Map
    - **2010 Urban Water Management Plan** (H2O Group 2012) – This document includes a description of water management tools and options used by the City to maximize resources and minimize the need to import water from other regions.
    - **Water Supply Assessment (**H2O Group 2010) – This document provides an assessment of the water demands associated with the General Plan Land Use alternatives, feasible water supplies options for meeting those demands, and description infrastructure associated with the water supply option.
    - **Non-Potable Water Master Plan and Feasibility Study** (H2O Group 2008) – this document evaluates the feasibility, benefits and costs of non-potable water supply system for the City.
    - **2014 January General Plan Poster Map** (City of Patterson 2014): This map shows the buildout land use.

3.2 Existing Water Consumption Data and Analysis

The City provided monthly water consumption data from 2011 through 2013 for 7,440 meter accounts. Each account is associated with a class code (commercial, irrigation, multi-family or residential), which groups the accounts based on their type of water usage. Table 3-1 summarizes the 2013 water consumption per class code, showing the City water usage at almost 4,000 AFY in 2013.

Table 3-1: 2013 Water Consumption Summary

Class Code	Class Description	Number of Accounts	2013 Demand (HCF)	2013 Demand (AFY)
C	Commercial	253	123,351	283
I	Irrigation	153	369,620	849
M	Multi-Family	28	20,388	47
R	Residential	7,006	1,210,133	2,778
Total		**7,440**	**1,723,492**	**3,957**

To understand City's billing class codes and their association with the existing land use designations, Table 3-2 was developed, which correlates the existing land use classification with the meter accounts class code from the water consumption data. Based on discussions with City staff, meter accounts classified as irrigation are for landscape irrigation only and there are no irrigation meter accounts for agriculture. Commercial and public/quasi-public parcels can be served by both irrigation and commercial meters.

Table 3-2: City's Meter Class Codes and Existing Land Use Association

Existing Land Use Category	Billing Class Description
Agriculture	Irrigation
Commercial	Irrigation/Commercial
Highway Service Commercial	Commercial
Industrial	Commercial
Neighborhood Village 20 Year	Residential
Public/Quasi-Public	Irrigation/Commercial
Residential	Residential/Multi-Family
Vacant	--

3.3 Determining Existing Duty Factors

The duty factor is defined as the ratio of the total consumption divided by total acreage of each land use designation. The sources of information for these calculations were the water consumption billing data and the City's existing land use GIS. Furthermore, the City provided the existing land use information via shapefile with a designated existing land use and APN number for each parcel. Multiple steps were used to correlate existing water usage data with the land use classifications. The following describes the process used to determine the existing duty factors:

1. Using the Account with Tax Lot spreadsheet, individual account numbers were correlated to an APN. The format of the APNs listed in the Account with Tax Lot spreadsheet was revised to match the APN format in the existing land use shapefile. Of the 7,440 billing accounts, 7,215 of them were successfully linked to an APN.
2. For the remaining 225 accounts, the following steps were taken to associate them with an APN:
    a. Existing and Future Non-Potable Accounts Spreadsheet was checked to see if additional accounts could be correlated to an APN. This method associated another 19 accounts with an APN number.

b. If an APN was not associated, the accounts were geocoded by their address in ArcGIS. Using the geocoding by address tool, the account point was placed in the middle of the street. Using the spatial join tool, the APN of the parcel closest to the point account was used.

c. A few accounts were not able to geocode as they did not have a specific address or the address was not found. Accounts not geocoded but had an address were then manually searched using Google Maps. Based on the location, and in conjunction with the City's GIS, the APN of the parcel that overlay that location was used.

3. Based on the first two steps, 7,333 accounts of the 7,440 billing accounts were associated with an APN. This accounted for over 98 percent relationship as well as over 96 percent of the water usage. Of the remaining accounts, 69 accounts did not have an APN number associated with it and 37 accounts had an APN number but the APN number was not found in any of the three parcel shapefiles (Existing Land Use, Buildout Land Use or the overall County parcels) provided.

4. With the 7,333 accounts associated with an APN, the accounts and water usage were consolidated by their individual APN. A total of 5,823 APN parcels were associated with a water billing account as some APN had multiple accounts/meters serving that parcel.

5. Next, the APN from the water usage data was linked to the APN in the existing land use GIS shapefile provided by the City. This shapefile was used to determine the land use of each account and the acreage of each existing land use.

Based on the total water usage by APN and the total acreage by land use, the duty factors were determined for each of the six existing land use category. Table 3-3 summarizes the acreage and total demand by land use categories.

Table 3-3: Existing Land Use Category Statistics

Existing Land Use Category	No. Accounts	Acres	2013 Demand (HCF)	2013 Demand (AFY)
Agriculture	6	152	8,697	20
Commercial	185	83	71,248	164
Industrial	97	238	54,415	125
Public/Quasi-Public	66	201	274,538	630
Residential	6,954	964	1,253,957	2,879
Vacant	26	241	5,981	13
Subtotal	**7,334**	**1,879**	**1,668,836**	**3,831**
Accounts with APNs not linked to GIS parcel	37	--	7,692	18
Accounts w/o APNs	69	--	46,964	108
Subtotal	**106**		**54,656**	**125**
Total	**7,440**		**1,723,492**	**3,957**

As previously mentioned, the City does not have any irrigation meter accounts for agriculture; however, some of the meter accounts linked to APNs are currently classified as agriculture parcels. These six parcels as well as the 26 vacant parcels were further investigated. Based on a cursory review of the Google Maps, most of these parcels were shown as developed. However, based on the existing land use shapefile, these parcels are labeled as vacant. This discrepancy can be attributed to the City developing rapidly and the existing land use shapefile not yet being updated to incorporate the recent developments. To gauge the

impacts of this discrepancy on the determination of the duty factors, the City identified the meter class code for most of the 32 customers to correctly associate them with the existing land use; however, these 32 accounts (26 associated with vacant and 6 accounts associated with agriculture), represent a small percentage of the total water usage (less than one percent). Therefore, it was determined that the discrepancies should not be investigated further as it would have minimal impacts on the calculation of the duty factors.

There were 106 accounts that were not associated with an existing land use (due to a no link to a GIS parcel or APN), however they represented a very small percentage of water demand. Their consumption was redistributed proportionally among the commercial, industrial, public/quasi-public and residential existing land use based on the volume of water usage by each respective land use category. Table 3-4 shows the redistribution of the accounts and the calculated duty factors for each of the existing land use designations.

Table 3-4: Existing Land Use Duty Factors

Existing Land Use Category	No. Accounts	Acres	2013 Demand (HCF)	2013 Demand (AFY)	Duty Factor (AFY/acre)
Agriculture	6	152	8,697	20	0.1
Commercial	190	83	73,602	169	2.0
Industrial	100	238	56,213	129	0.5
Public/Quasi-Public	84	201	283,609	651	3.2
Residential	7,034	964	1,295,390	2,974	3.1
Vacant	26	67	5,981	14	0.2
Total	**7,440**	**1,705**	**1,723,492**	**3,957**	

3.4 Projecting Buildout (2050) Potable Consumption

There are a variety of methods for projecting future demands. Based on conversations with City staff, it was determined that a land use method should be used for this Master Plan. This approach allows for rigorous, spatially-based demand projections that are tied to local land use plans by land use type.

In order to project water usage in the future, duty factors (water use per acre) were determined based on existing data. Based on the duty factors and the future land use, the buildout demand was determined. The existing land use, which was the basis of this analysis, is presented in Figure 3-1.

Buildout water use projections were developed using information from the Buildout Plan. While the existing plan has four land use type designations, not including the agriculture and vacant land use types, the Buildout Plan has 15. Therefore, an initial correlation was made between the existing land use designations and those presented in the Buildout Plan, with more than one buildout land use designation related to each of the existing lnad use types. Table 3-5 shows the correlation between the existing and buildout land use designations and their duty factors.

As shown in the table, the buildout plan has six categories for residential land use ranging from estate residential to high density residential. Using a single duty factor for all the residential land use would not be adequate since the consumption among all six categories is different. Consequently, more refined duty factors were developed to provide a better estimate for buildout projections. The existing water duty factors were compared with the duty factors calculated in the 2010 WSA. The 2010 WSA has the same residential land use categories as the Buildout plan, so those duty factors were incorporated into the duty factors for the various residential land use types. Once the WSA factors were incorporated into the residential duty factors, all duty factors were adjusted based on shifting development standards (such as units per acre) and

anticipated water use (gallons per capita per day) to develop the final duty factors. These revised duty factors, shown in Table 3-5, were used to determine the projected 2030 and 2050 buildout demands.

Table 3-5: Buildout Land Use Duty Factors

Buildout Land Use Designation	Ex. Land Use Category	Calculated Duty Factor (AFY/acre)	Revised Duty Factor (AFY/acre)
Residential			
Mixed Use	Residential	3.1	**2.2**
Neighborhood Village	Residential	3.1	**2.0**
Estate Residential	Residential	3.1	**1.0**
Low Density Residential	Residential	3.1	**1.9**
Medium Density Residential	Residential	3.1	**1.1**
High Density Residential	Residential	3.1	**2.5**
Downtown Residential	Residential	3.1	**2.6**
Non-Residential			
Downtown Core	Commercial	2.0	**4.6**
General Commercial	Commercial	2.0	**0.8**
Highway Service Commercial	Commercial	2.0	**1.0**
Medical Professional	Commercial	2.0	**0.4**
Light Industrial	Industrial	0.5	**0.4**
Heavy Industrial	Industrial	0.5	**0.4**
Public/Quasi-Public	Public/Quasi-Public	3.2	**1.1**
Parks/Open Space	Public/Quasi-Public	3.2	**2.6**
Lake/Other	--	0.0	**0.0**

3.5 Non-Potable Analysis

Further analysis was conducted by identifying the existing and future non-potable accounts. The City provided the Existing and Future Non-Potable Accounts Spreadsheet, which listed the existing and proposed non-potable account numbers. The proposed non-potable account numbers are existing potable accounts identified as Phase III of the City's Non-Potable Water Program. The Non-Potable Water Program consists of five phases and only Phase III meter accounts have been identified for future non-potable consumption to date by the City. Existing and future non-potable accounts are summarized in Table 3-6.

Two non-potable accounts were associated with the vacant land use. As previously mentioned the City is developing rapidly and the existing land use shapefile was not yet updated to incorporate these recent developments.

Table 3-6: Non-Potable Accounts and Consumption

Existing Land Use	No. Accounts	Acres	2013 Demand (HCF)	2013 Demand (AFY)
Existing Non-Potable Accounts				
Public/Quasi-Public	13	129	117,092	269
Vacant	2	36	464	1
Subtotal	**15**		**117,556**	**270**
Future Non-Potable Accounts				
Public/Quasi-Public	10	42	54,775	126
Total	**25**	**207**	**172,331**	**396**

3.6 Unaccounted-for Water

Unaccounted-for water is defined as the difference between the total amount of water produced and the total amount of water consumed (sold). For systems without customer meters, the volume of unaccounted-for water may not be quantifiable. Generally, the unaccounted-for water includes water for fire hydrant flushing, street sweeping, construction use, well site flushing, and unmetered use.

The City provided monthly consumption and pumped data for 2012 through 2014, which was used to determine the volume of unaccounted-for water. In general, monthly water consumption should be less than the water pumped. However, due to old meters or reading errors, some months had higher consumption values than water pumped. For those months, it was assumed all water consumed was also produced. Based on those adjustments, the unaccounted-for water ranges from 10 to 15 percent by year, averaging 12 percent. Table 3-7 summarizes the unaccounted-for water analysis.

Table 3-7: Unaccounted-For Water Percentage

Year	Pumped (MG)	Consumption (MG)	Difference [1] (MG)	Unaccounted Loss Percentage
2012	1351	1247	132	10%
2013	1488	1278	223	15%
2014	1317	1180	160	12%
			Average	**12%**

Notes:

1. These values have been adjusted to account the meter reading errors and therefore, the difference is greater when compared to the total pumped minus the total consumption.

3.7 Demands and Adjustments for Unaccounted for Water

3.7.1 Existing Demands

As discussed previously in this chapter, the existing demands represent a baseline for evaluating the existing distribution system and demands projections. The data used to develop the existing demands was based on historical water consumption and production data provided by the City. Using the unaccounted-for water analysis, the existing demands were updated to include an assumed volume of unaccounted-for water. For the sake of this plan, it was assumed that unaccounted-for water (at the average rate of 12%) was spread proportionally throughout the City. A summary of the existing water use is presented in Table 3-8.

Figure 3-1: Existing Land Use

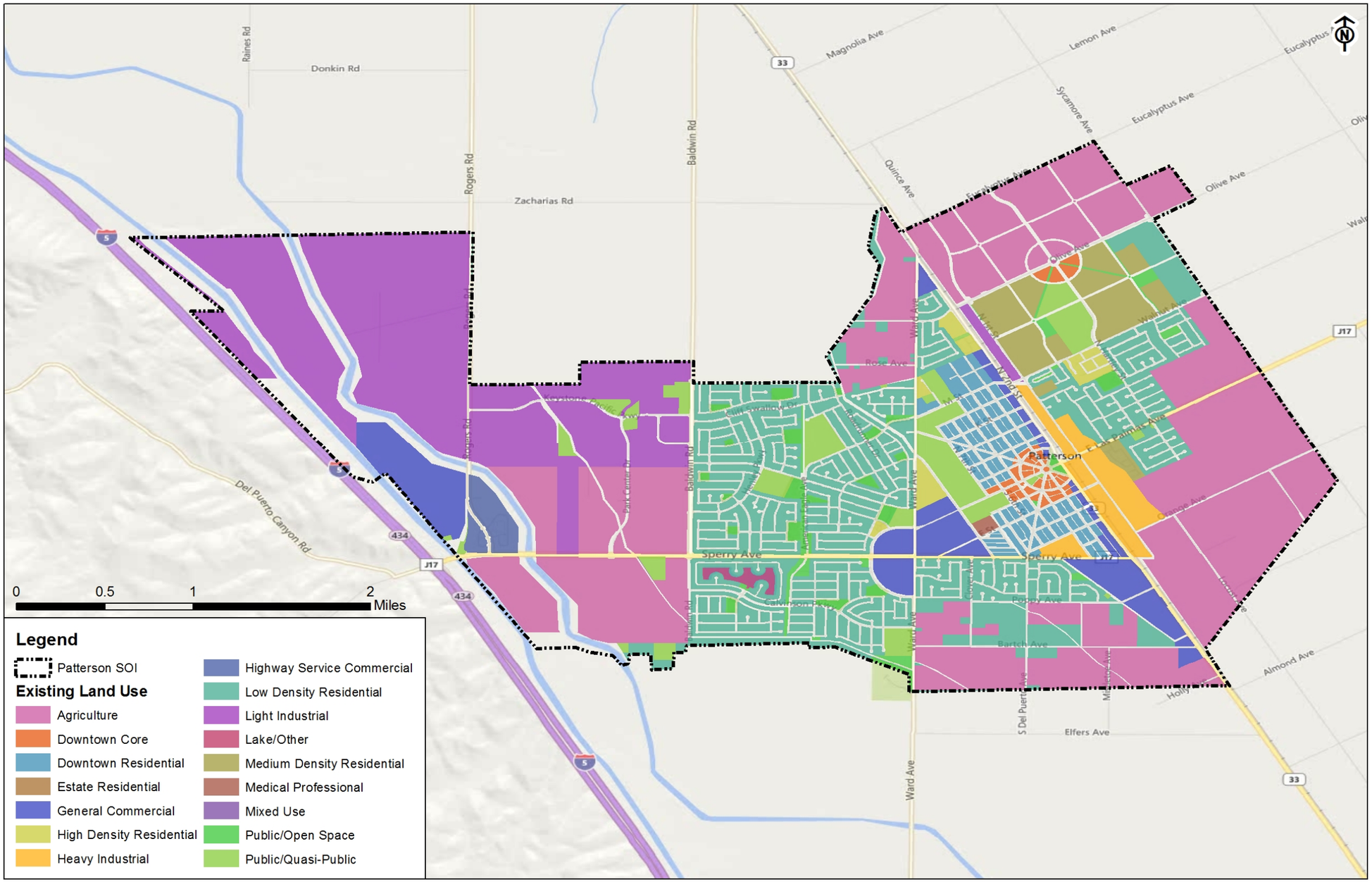

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Table 3-8: Existing Potable and Non-Potable Water Demand

	No. Accounts	2013 Demand (HCF)	2013 Demand (AFY)
Potable Accounts			
Agriculture	6	8,697	20
Commercial	190	73,602	169
Industrial	100	56,213	129
Public/Quasi-Public	71	166,517	382
Residential	7,034	1,295,390	2,974
Vacant	24	5,517	13
Subtotal	**7,425**	**1,605,936**	**3,687**
Non-Potable Potable Accounts			
Public/Quasi-Public	13	117,092	269
Vacant	2	464	1
Subtotal	**15**	**117,556**	**270**
Total Consumption	**7,440**	**1,723,492**	**3,957**
Unaccounted for Water (12%)			475
Total Demand (AFY)			**4,432**

3.7.2 Demand Projections

Using the duty factors presented in Section 3.4 and land use information, projected water demands for 2030 and 2050 were calculated. Projected demands are summarized by land use type (at buildout) in Table 3-9 and a breakdown of the demand projections for the City's sphere of influence for 2013, 2030 and 2050 is presented in Table 3-10.

Table 3-9: Buildout Potable and Non-Potable Water Demands

Land Use Designation	Buildout Area (acres)	Duty Factor (AFY/acre)	Buildout Water Usage (AFY)	Non-Potable (AFY)	Potable (AFY)
Residential					
Mixed Use	575.4	**2.2**	**1,266**		1,266
Neighborhood Village		**2**	**0**		0
Estate Residential	912	**0.98**	**893**		893
Low Density Residential	3,915	**1.95**	**7,635**		7,635
Medium Density Residential	337.79	**1.12**	**378**		378
High Density Residential	45.65	**2.5**	**114**		114
Downtown Residential	128.28	**2.6**	**334**		334
Non-Residential					
Downtown Core	40	**4.58**	**183**		183
General Commercial	680.8943	**0.78**	**531**		531
Highway Service Commercial	90.95	**0.98**	**89**		89
Medical Professional	30.5076	**0.4**	**12**		12
Light Industrial	1,640	**0.4**	**656**		656
Heavy Industrial	451.791	**0.4**	**181**		181
Public/Quasi-Public	1177.541	**1.12**	**1,319**	396	923
Parks/Open Space	403.219	**2.57**	**1,036**		1,036
Lake/Other	12.3	**0**	**0**		0
Total Consumption (AFY)			**14,627**	**396**	**14,231**
Unaccounted for Water (12%)			1,755		
Total Demand (AFY)			**16,383**		

Table 3-10: Potable and Non-Potable Water Demand Projections

	2013	2030	2050
Potable Average Annual Demand (AFY)	3,687	9,390 [1]	14,231
Non-Potable Average Annual Demand (AFY)	270	--	396 [2]
Total Consumption (AFY)	**3,957**	**9,390**	**14,627**
Unaccounted for Water (AFY) [3]	475	766	1,708
Total Demand (AFY)	**4,432**	**10,156**	**16,335**

Notes:

4.1. Potable average annual demand for 2030 was determined using interpolation from existing to buildout demands.

5.2. The non-potable average annual demand only account for Phase III of the Non-Potable Water Program. Future non-potable demands will be revised based on anticipated non-potable retrofits. This will be discussed in Chapter 6.

5.3. The unaccounted-for water is based on 12 percent of the total demand.

Chapter 4 Supply Options

4.1 Groundwater Analysis

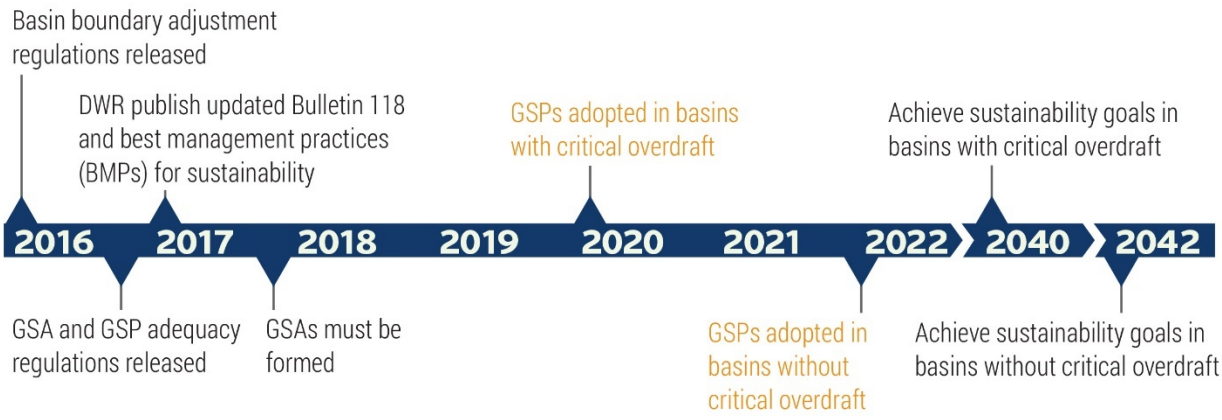
As discussed in Chapter 2, the City currently utilizes groundwater as its sole water source. To determine the sustainability of this practice and the potential to expand the City's use of groundwater, an evaluation was conducted to determine the recharge capacity of the local aquifers and the potential groundwater yield. This evaluation consisted of numerical modeling of the Delta-Mendota Groundwater Basin region surrounding the City and fieldwork, as described in the following sections.

4.1.1 Sustainable Groundwater Management Act

In November of 2014, the Sustainable Groundwater Management Act (SGMA) was signed into law (AB 1739, SB1168 and SB 1319). Implemented beginning January 1, 2015, SGMA establishes a framework under which the State and regional agencies will oversee sustainable use and management of medium- and high-priority groundwater basins (as defined by SGMA regulations). SGMA requires the formation of Groundwater Sustainability Agencies (GSAs) to oversee basins and the preparation and implementation of Groundwater Sustainability Plans (GSPs) to achieve and maintain sustainability in each basin. The City has taken an active role in the SGMA process, engaging with neighboring agencies and stakeholders to begin development of a GSP for the Delta-Mendota Groundwater Basin.

This WMP was prepared with SGMA in mind, recognizing that sustainable groundwater management will be extremely important to providing the City with a long-term reliable water supply, and that, at this time, there is still uncertainty regarding how sustainability will be defined, what the GSP will include to reach basin sustainability, and what exactly it will mean for the City. The City recognizes that this assessment may need to be revisited and/or expanded on as sustainability programs are developed for the GSP. A summary timeline of the SGMA legislative deadlines is presented in Figure 4-1.

Figure 4-1: Summary of the SGMA Timeline



4.1.2 Operational Yield

An Operational Yield Study (OYS) was conducted to determine an estimated volume of groundwater that the City could extract from the underlying Delta-Mendota Groundwater Subbasin without impacting their current groundwater pumping infrastructure and without significantly impacting the use of groundwater resources in the area surrounding the City's Sphere of Influence (SOI). The OYS was conducted using C2VSim, an integrated numerical model that simulates water movement through the linked land surface, groundwater and surface water flow systems in the Central Valley. The model was developed for and is

used by the California Department of Water Resources (DWR) for evaluating groundwater use, surface water-groundwater interactions, and surface water resources management in the Central Valley.

Methodology and Modeling

Modeling scenarios simulated using C2VSim evaluated three primary parameters: the volume of groundwater to be extracted in the future (and associated pumping schedule), the location of existing wells and potential future additional wells, and groundwater pumping during potential recurring droughts contained in the modeling hydrologic period. The model used available pumping rates from neighboring groundwater users, but did not account for any potential changes to land use or water consumption for those users. The model groups pumping, recharge and water use by model grid cell, but more specific well location (actual, for existing wells and potential for new ones) was used for the City's wells for this analysis.

The overall goal of the OYS analysis was to identify the maximum volume of groundwater that the City could extract in the future, through buildout, without resulting in significant impacts (defined herein as drawdown) in aquifers above and below the Corcoran Clay layer outside the City's SOI. Changes in the City's pumping volume, number of well fields utilized and hydrologic conditions were combined to develop model scenarios in an iterative approach. Baseline (current groundwater use) analyses were run to provide a point from which to evaluate each of the future scenarios. Table 4-1 summarizes the different scenarios simulated in the model runs.

Table 4-1: Summary of Model Scenarios

Scenario	Buildout (2015) Pumping Volume (AFY)	No. of Well Fields Utilized[5]	Model Hydrology[6]
Base AB	4,200[1]	1	Default
Base C	4,200[1]	1	Shifted Critical Drought
1A	24,700[2]	1	Default
1B	24,700[2]	2	Default
1C	24,700[2]	1	Shifted Critical Drought
2A	12,000[3]	1	Default
2B	12,000[3]	2	Default
2C	12,000[3]	1	Shifted Critical Drought
3A	6,000[4]	1	Default
4A	10,000[4]	1	Default

Notes:

~~5.~~1. Assumes pumping value remains constant at 2012 pumping rates (prior to reductions from the drought taking place).

~~5.~~2. Buildout volume from the 2010 Water Supply Analysis. Pumping rates utilized five-year steps to a projection in 2030 and then new step values from 2030 to the buildout value in 2050.

~~5.~~3. Buildout volumes from 2015 RMC demand analysis.

~~5.~~4. Buildout volume selected to try to determine the operational yield with minimal impacts outside City's SOI.

5. If one well field is utilized, it is assumed that all pumping will occur in the general vicinity of the existing wells (in the eastern portion of the City). If two well fields are utilized, future wells will be constructed in the northwest portion of the City.

~~5.~~6. The default hydrology includes a significant drought event in the middle of the model run. Alternatively, the critical drought was rerun at the end of the model simulation period to align with the highest pumping rate and reflect a maximum water demand and potential impacts to the groundwater basin.

Results

Once the C2VSim modeling scenarios were completed, the results were processed and compared to the appropriate baseline results to assess the effects of future Patterson pumping on regional groundwater levels as well as potential impacts to the City's existing production wells. C2VSim produces groundwater elevation data for both above (layer 1) and below (layer 2) the Corcoran Clay. As discussed in Section 2.2.1, the Corcoran Clay layer is a regional aquitard that plays an important role in the hydrogeology of the region and

effectively separates groundwater above it from that below it; as such, the depth of groundwater pumping may have a greater impact above or below the Corcoran Clay (depending on an individual well's screened depth).

The following observations can be made about the resulting groundwater level contours:

- The difference in the size (area) of the zone of influence between model runs pumping from one or two well fields is not significant. This is likely due to the spacing of the wells relative to the size of the C2VSim elements. [3]
- Repeating the 1987-1992 drought (the critical drought) at the end of the model simulation period (to coincide with the highest demand period) does not appear to have a significant impact on the overall pumping impacts.
- The larger the buildout demand, the greater the difference in the drawdown between layer 1 and layer 2. Some of the City's wells are screened across the Corcoran Clay layer as it is represented in C2VSim; that is, the wells 'pump' from both layer 1 and layer 2 in the model. As pumping demands increase, the model appears to increase the contribution of flows from layer 1 to supplement the pumping from layer 2.

The following observations can be made about the groundwater hydrographs:

- There does not appear to be any significant impacts on the City's existing wells (evaluated as groundwater levels dropping below the well screen) in any of the model runs.
- The maximum drawdown in both layer 1 and layer 2 for any model run is approximately 32 feet.

As shown in Figure 4-2 and Figure 4-3, a buildout pumping value of around 10,000 AFY (such as in Scenario 4a) appears to be a groundwater pumping rate the City can sustain while limiting the pumping zone of influence to the City's SOI.[4] As this analysis does not capture the impacts to all potential beneficial uses of water in the area nor does it explicitly look at non-City infrastructure, the City will conduct additional assessment of potential impacts to the surrounding groundwater levels and infrastructure prior to installing a new groundwater well. The complete Operational Yield TM can be found in Appendix B.

[3] A finer grained model scenario may indicate a significant difference between the model runs using one or two well fields.

[4] Should the results of SGMA-related analysis and planning conflict with the groundwater analysis presented in this WMP, the recommended supply portfolio (discussed in Section 6.4) can be adjusted based on the analysis of non-groundwater supplies presented in this WMP to fill any resulting supply gap.

Figure 4-2: Scenario 4a Groundwater Hydrograph

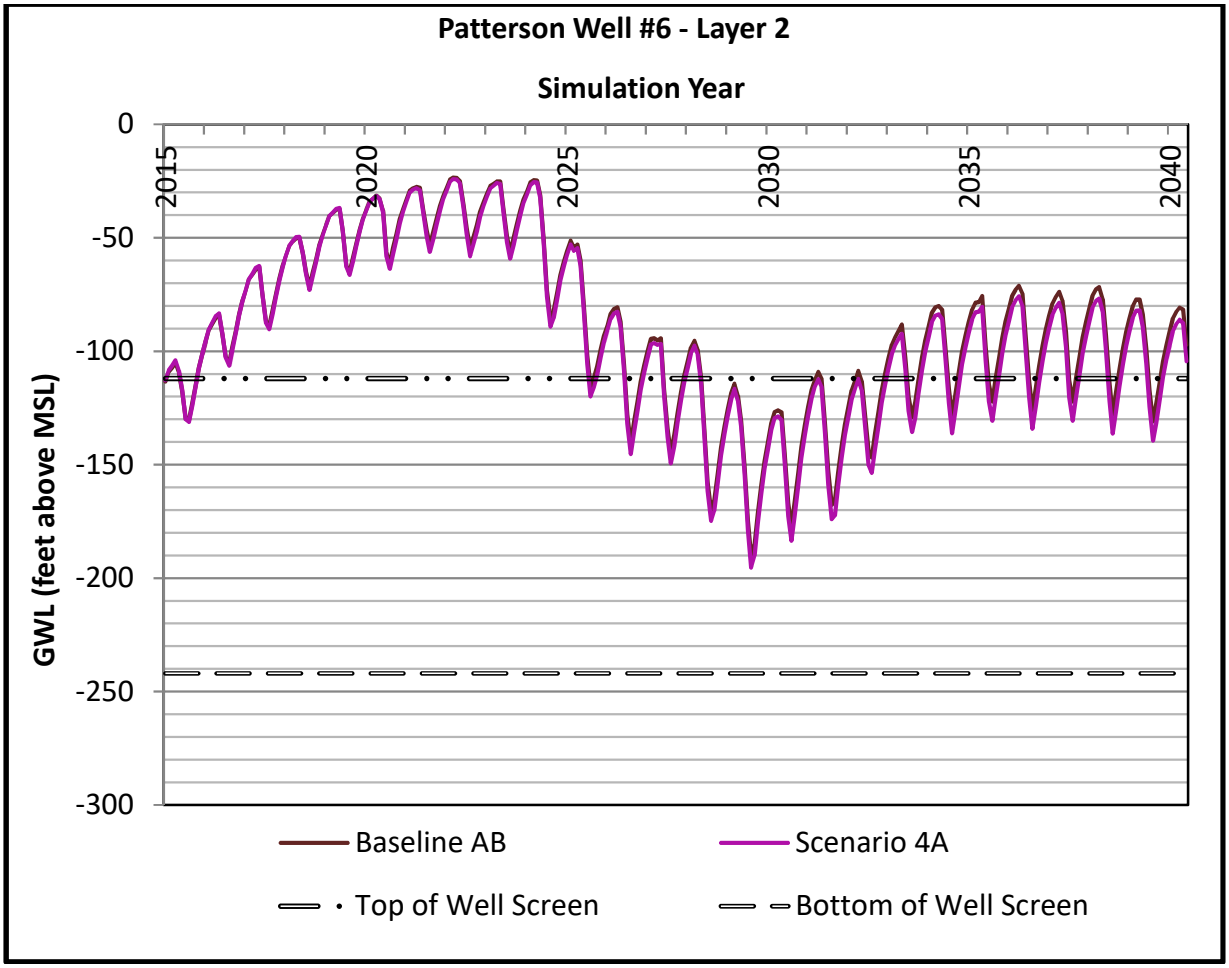
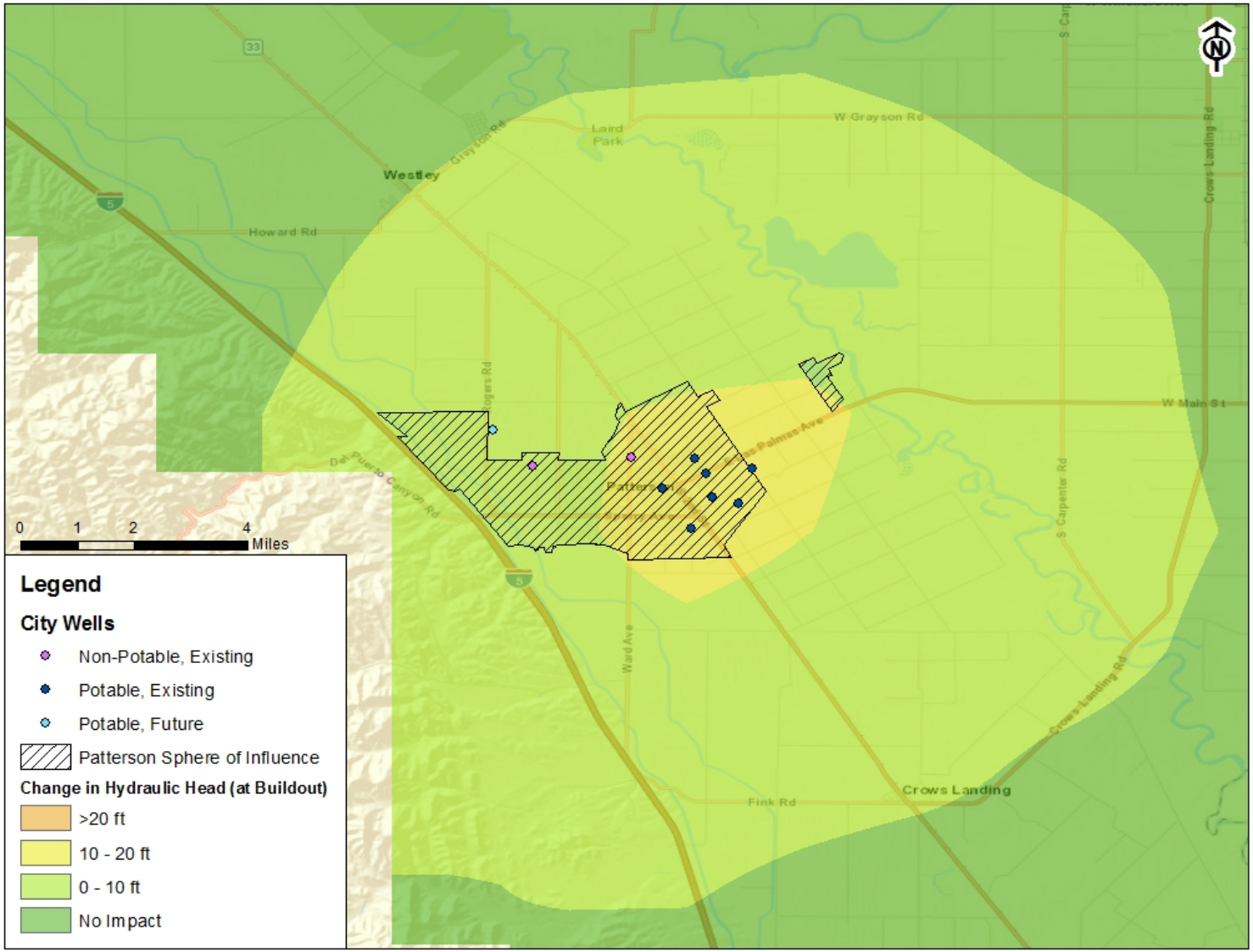


Figure 4-3: Scenario 4a Groundwater Level Contour Below Corcoran (Zone of Influence)



4.1.3 Field Investigation and Groundwater Studies

As part of the analysis of the local groundwater basin, a groundwater study and fieldwork was conducted to determine the recharge feasibility of the local aquifers. The groundwater study was scoped to build on previous studies of the subsurface geological conditions which indicated a thinning of the Corcoran Clay on the western edge of the City (KSA 2010). The updated analysis conducted as part of this WMP relied on new boring logs and well tests to develop an initial analysis and identify areas to pursue additional borings.

The updated analysis, conducted by Ken Schmidt and Associates as part of this master plan and included in Appendix C, concludes the following:

- Shallow conditions, which are considered important in terms of surficial material that may need to be excavated and could be restricting, indicate potentially favorable conditions (a minimal amount of fine-grained material) primarily north of Zacharias Road, between Raines and Rogers Roads, however they do appear extend to the southwest of the DMC as well.
- The subsurface geologic cross sections include a transition from the Corcoran Clay to a "Corcoran Clay equivalent." This clay layer is present in most of the logs evaluated and indicate the clay pinching out somewhere east of the California Aqueduct. For much of the area, the clay ranges from 25 – 40 feet thick.
- Recharge southwest of the DMC could potentially benefit the lower aquifer.

Based on the conclusions of this study, further field investigation was planned to gather additional information regarding the underlying soil conditions to help identify possible locations for a pilot recharge project. Locations for new borings were selected and a field investigation was completed in July 2017. The recent soil boring locations and depths and cross section identifications are presented in Figure 4-4 and cross sections are presented in Figures 4-5 to 4-7. Boring logs from the fieldwork are included in Appendix D. Results of the new borings indicate the following:

- Confirmation of other boring logs conducted in the area.
    - There are interfingered layers of clay and silt between sand and gravel leading to Corcoran Clay-equivalent layers to the east.
    - The extent of clay, both in thickness and number of interfingered layers, increases to the east, with clay layers thinning to the west near the DMC and California Aqueduct.
    - The best conditions for potential surface recharge/percolation is west of the DMC.
- Percolation ponds should be sited as far west as possible, ideally between the DMC and California Aqueduct.[5]
- Percolation pond design will likely require the excavation of shallow silt and clay layers and/or deep tillage to provide connection to underlying sands and gravels.

Based on these results, pilot recharge project(s) should be sited as far west as possible (likely between the DMC and California Aqueduct) and/or adjacent to existing stream beds to determine site-specific specific recharge capacities.

[5] To site a percolation pond in between the DMC and California Aqueduct, the property would need to be acquired or an easement obtained, an EIR would need to be prepared and all relevant permits would need to be obtained.

Figure 4-4: New Boring Locations and Cross Section Identification

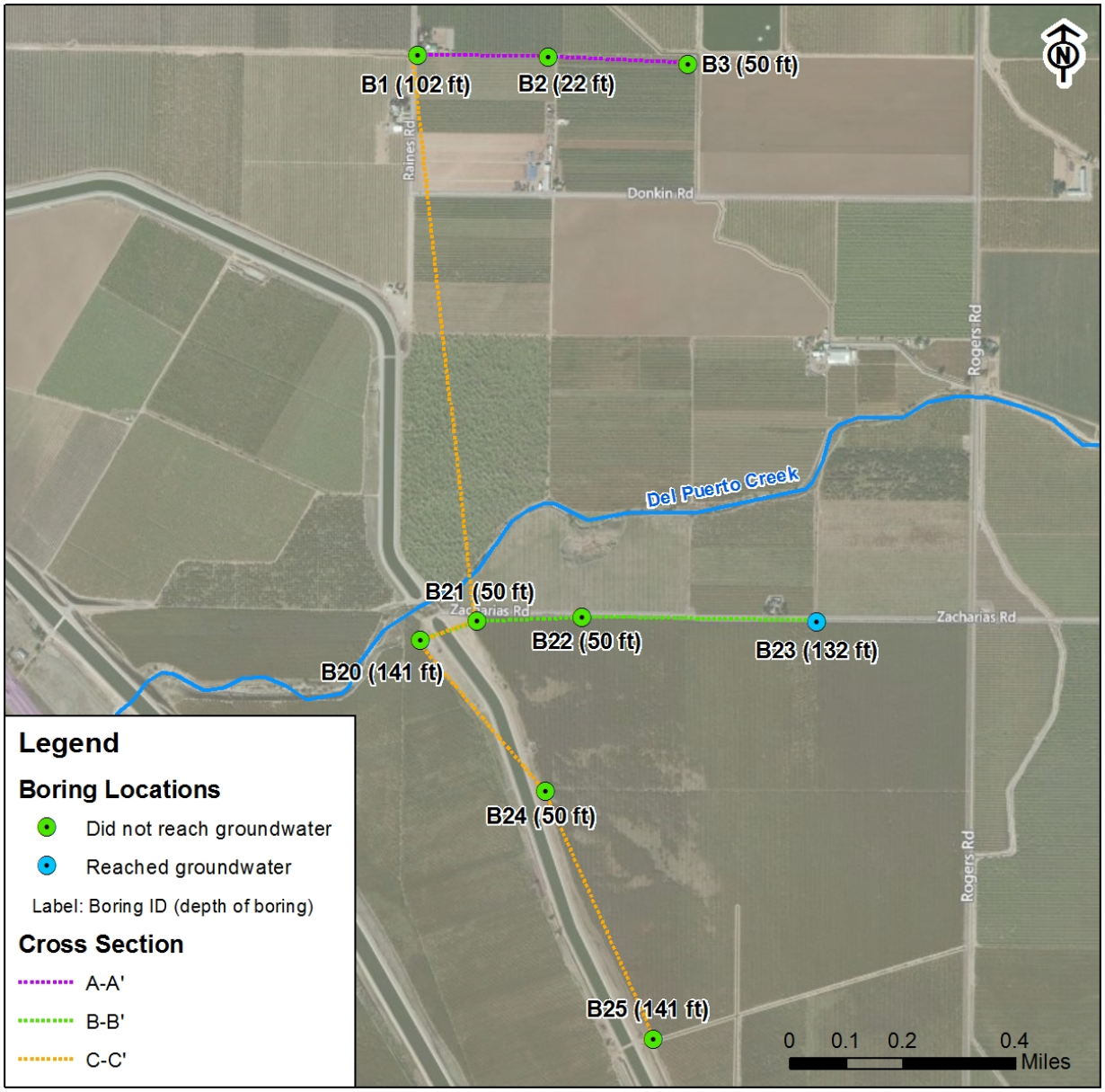


Figure 4-5: Cross Section A-A'

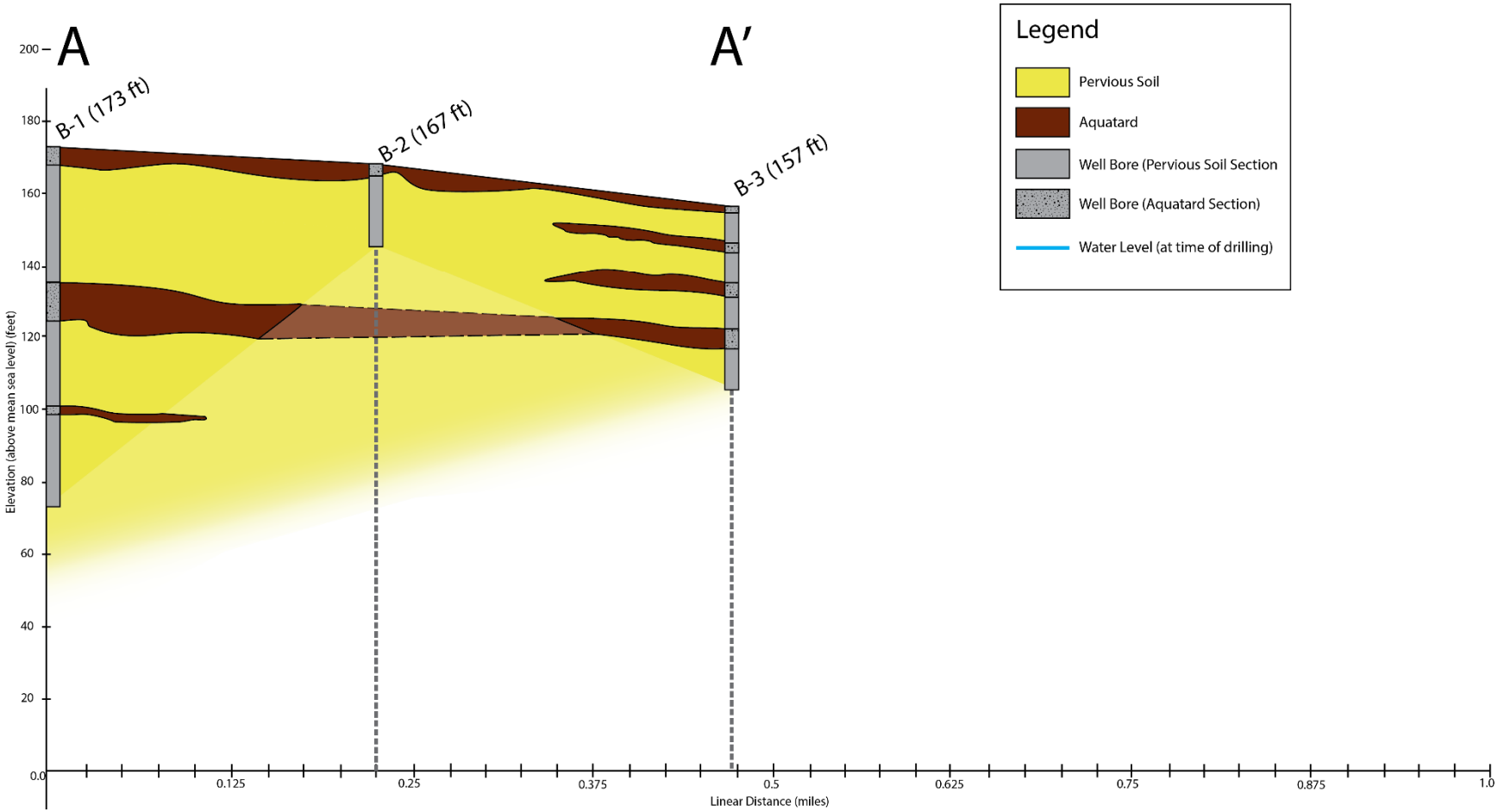


Figure 4-6: Cross Section B-B'

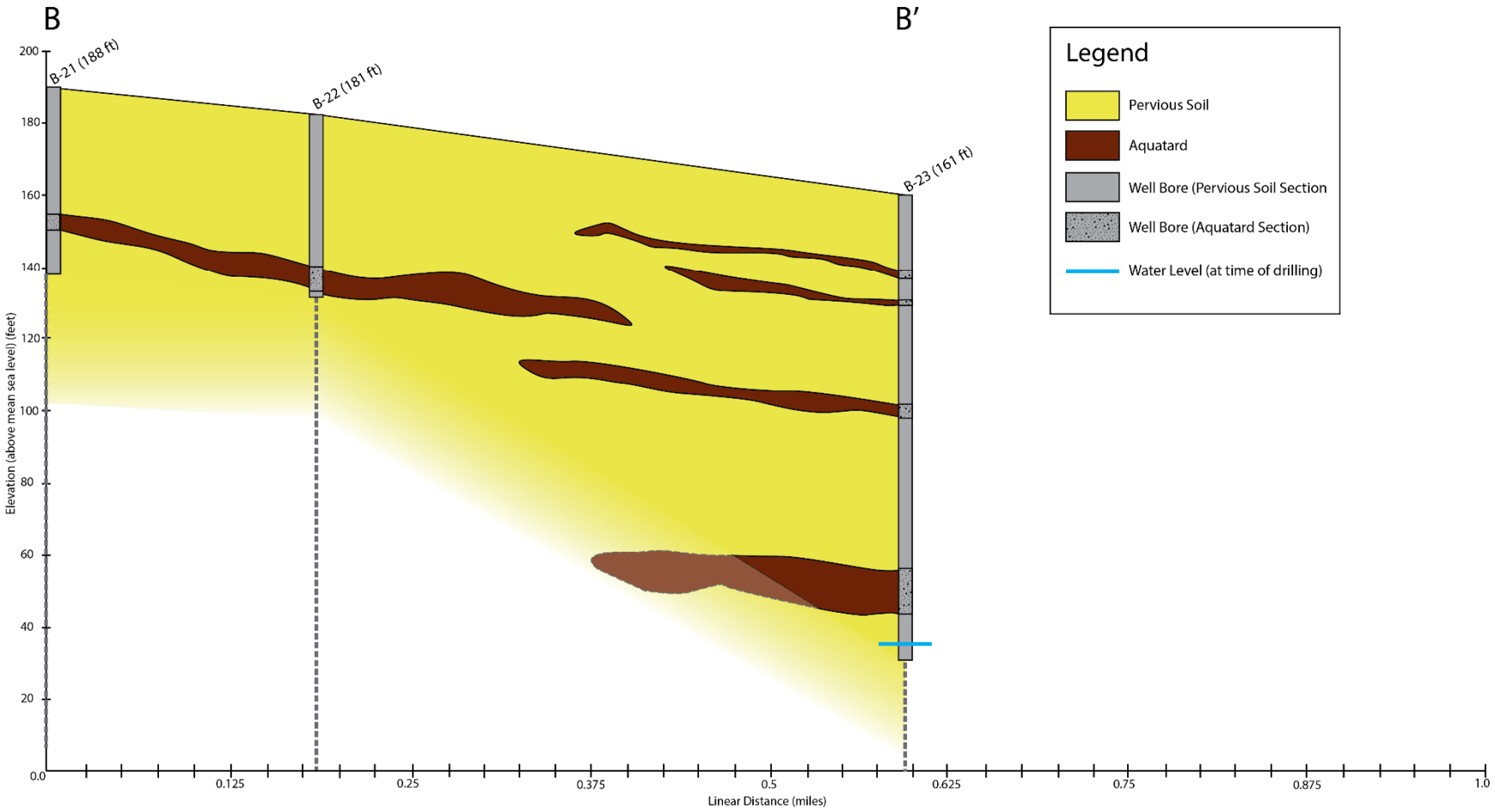
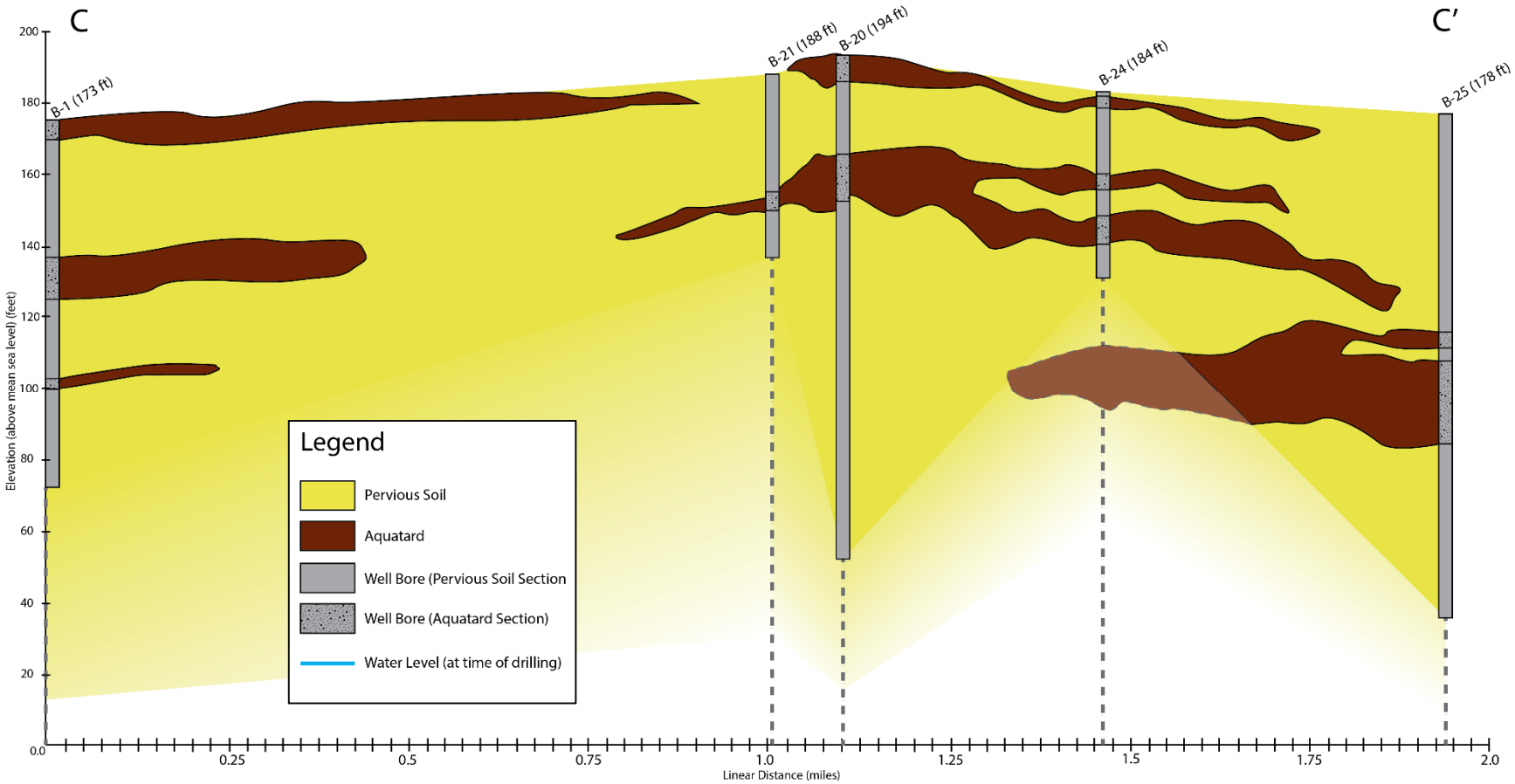


Figure 4-7: Cross Section C-C'



4.1.4 Land Subsidence

Land subsidence, caused by pumping water out of the confined aquifer below the Corcoran Clay, is a major concern in the Central Valley and around the City. While this Master Plan does not include any assessment of land subsidence, the City is part of the United States Geological Survey led San Joaquin Valley land subsidence monitoring program, regularly checking subsidence around the City. The City will continue to monitor land subsidence while it pumps groundwater and will conduct additional review prior to the implementation of any new groundwater wells to ensure that the project will not cause any significant subsidence.

4.2 Supply Options Description

To determine the preferred source of future potable supply, a comprehensive list of potential supply sources was developed. In addition to the expansion of groundwater use, 12 other conceptual supply options were explored as possible sources of potable or non-potable supply. Those supply options are described in this section and preliminary, planning-level cost estimates are provided for the required facilities. For the sake of this plan, it was assumed that any new wells will require Chromium VI treatment and TDS reduction (reverse osmosis (RO)). A more comprehensive analysis of the need for Chromium VI treatment, the treatment options and a cost estimate is available in the Chromium VI Feasibility Study (Appendix A). Future fieldwork and analyses will be needed prior to the design and construction of TDS reduction treatment. It was assumed that in order to exchange recycled water with any partnering agency for potable water, the City would receive an exchange rate of 10:9, with the difference being a "payment" for the exchange.

4.2.1 North Valley Regional Recycled Water Plant (RRWP)

The City would transfer water from the Patterson WQCF (via pump station and pipeline) to the Modesto Tertiary treatment plant (Jennings Plant). Once treated, the water would be transported to the DMC and then diverted out of the canal downstream for use in Patterson. The diverted DMC water will be routed through a (to-be-constructed) surface water treatment plant (SWTP) before connection to the potable distribution system.

Figure 4-8: North Valley Regional Recycled Water Plant

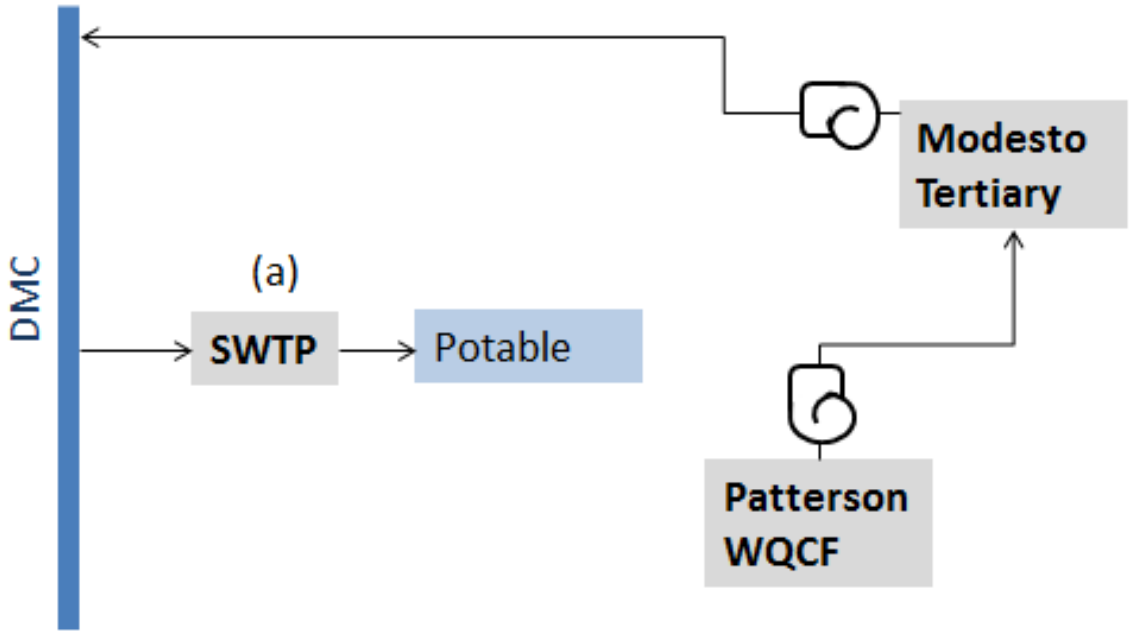


Table 4-2: Cost Estimate for the North Valley RRWP Supply Option

Project Component	Capital Cost (O&M)
Pump at WQCF	$1,356,000 ($74,600)
Force Main (WQCF to Jennings Plant)	$5,450,000 ($54,500)
Jennings Plant[1,2]	$ -- ($40,000)
Pump at Jennings Plant[1,2]	$ -- ($280,500)
Force Main (Jennings Plant to DMC)[2]	$3,532,000 ($ -)
Wheeling Cost for DMC	$ -- ($30 / AF * 5,600 AFY = $168,000)
Intake at DMC	$150,000 ($1,500)
Gravity Main (DMC to SWTP)	$972,000 ($9,700)
SWTP (and system hookup)	$30.5M ($756,000)
Total	**$42.0M ($1,385,000)**

Note:

1. These are the estimate incremental costs to operate the facilities with the added flow from Patterson
2. It is assumed that Patterson would be responsible for the difference in the capital cost to upsize the pipeline to accommodate the additional flow, but would only pay for O&M related to the treatment and pumping, not for the pipeline

4.2.2 Treat Wastewater for Non-Potable Reuse with Percolation Ponds

The WQCF will be retrofitted to treat water to non-potable Title 22 standards after which the effluent will be pumped to infiltration ponds (to be constructed) near the existing non-potable wells. In addition to pumping from the existing wells, new shallow wells will be constructed for non-potable water supply.

Figure 4-9: Patterson's Own Recycled Water for Non-Potable Use with Percolation Ponds

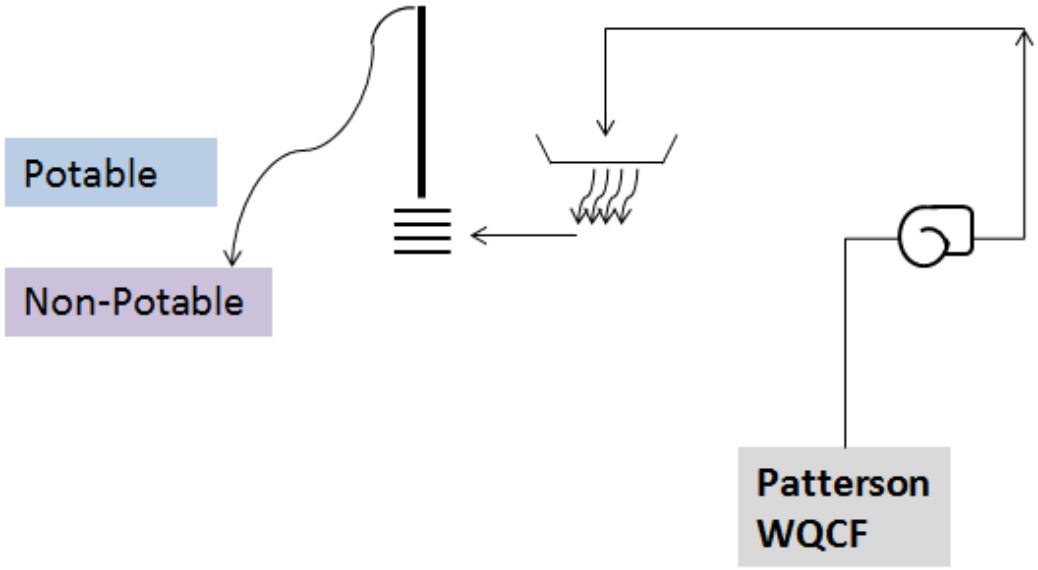


Table 4-3: Cost Estimate for Title 22 Treatment and Reuse (Percolation)

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Pump at WQCF	$4,568,000 ($417,600)
Force Main (WQCF to ponds)	$7,152,000 ($71,500)
Land Acquisition	$600,000 ($ -)
Infiltration Ponds	$13.2M (600,000)
Shallow Wells	$5,450,000 ($189,000)
Total	**$38.6M ($1,318,000)**

4.2.3 Del Puerto Creek Stormwater Capture

Seasonal stormwater flows from Del Puerto Creek can be captured and diverted to infiltration ponds. Pending a groundwater study, these ponds would recharge the shallow aquifer (for non-potable use) and/or deep aquifer (for potable reuse). Water could then be pumped from these aquifers from new wells. This stormwater project would be in addition to the City's current requirement that all new development include stormwater retention and percolation on site. The yield of those projects has not bee calculated at this time.

There is also the potential to capture streamflow from Salado Creek or Black Gulch, though no hydrograph data was available at the time of this master planning effort to estimate annual average flows and approximate yields. Beneficial use of stormwater will likely be an important part of the GSP, so the City will work with neighboring agencies to maximize beneficial use of the available stormwater in the region. The exact location for streamflow capture and infiltration will be determined with additional field work and pilot testing to assess the infiltration capacity of the soils near the creeks. For this Master Plan, capture from Del Puerto Creek (presented below) will serve as a placeholder for the approximate yields and costs for this supply option.

Figure 4-10: Del Puerto Creek Stormwater Capture

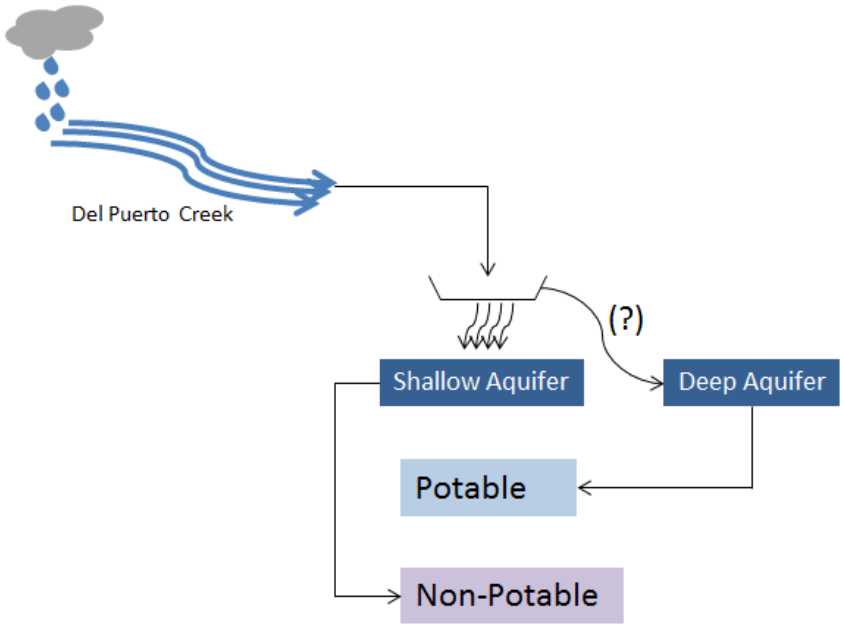


Table 4-4: Cost Estimate for Del Puerto Creek Stormwater Capture

Project Component	Capital Cost (O&M)
Land Acquisition	$280,000
Infiltration Ponds	$6,149,000 ($280,000)
Wells	$1,364,000 ($47,000)
Total	**$7,793,000 ($327,000)**

4.2.4 Exchange for State Water Project Water

The WQCF will be retrofitted to produce non-potable Title 22 water. The effluent will then be pumped to the DMC or California Aqueduct and conveyed to a State Water Project (SWP) contractor for non-potable use in exchange for State Water Project water to be treated for potable use. In option (a), water is diverted from the California Aqueduct to a SWTP and then used in the potable distribution system. Alternatively (option (b)), Patterson can treat the CA water and then inject it to the deep aquifer for future potable extraction from new deep wells. Water is to be exchanged at an estimated 10:9 rate (Patterson recycled water to SWP water).

Figure 4-11: State Water Project Water Exchange

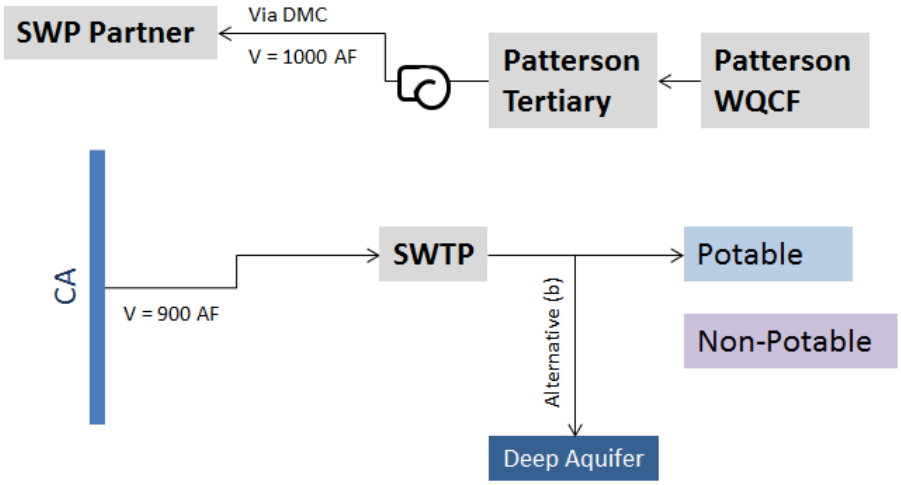


Table 4-5: Cost Estimate for State Water Project Water Exchange

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Pump (WQCF to CA)	$3,294,000 ($258,600)
Forcemain (WQCF to CA)	$11,366,000 ($113,660)
Wheeling Cost for CA	$ -- ($30 / AF * 5,600 AFY = $168,000)
Intake on CA	$135,000 ($1,350)
Gravity Main (intake to SWTP)	$1,511,000 ($15,110)
SWTP (and system hookup)	$27,651,000 ($682,300)
(b) SWTP and Injection Wells	$28,650,000 ($752,500)
(b) Deep Wells	$3,717,000 ($114,000)
(b) Chromium VI Treatment	$12,285,000 ($2,340,000)
(b) RO Membrane Treatment	$25,415,000 ($2,541,000)
(b) RO Brine Disposal	$50,354,000 ($644,500)
Total (a – to distribution system)	**$51.6M ($1,279,000)**
Total (b – to injection wells)	**$144.4M ($6,989,000)**

4.2.5 Exchange with Central Valley Project Contractor

The WQCF will be retrofitted to produce non-potable Title 22 water. The effluent will then be pumped to a Central Valley Project (CVP) contractor (water delivered through the DMC) for non-potable use in exchange for CVP water for treatment and potable use. In option (a), water is diverted from the DMC to a SWTP and then used in the potable distribution system. Alternatively (b), Patterson can treat the DMC water and then inject it to the deep aquifer for future potable extraction from new deep wells. Water is to be exchanged at an estimated 10:9 rate (Patterson recycled water to CVP water).

Figure 4-12: Central Valley Project Contractor Water Exchange

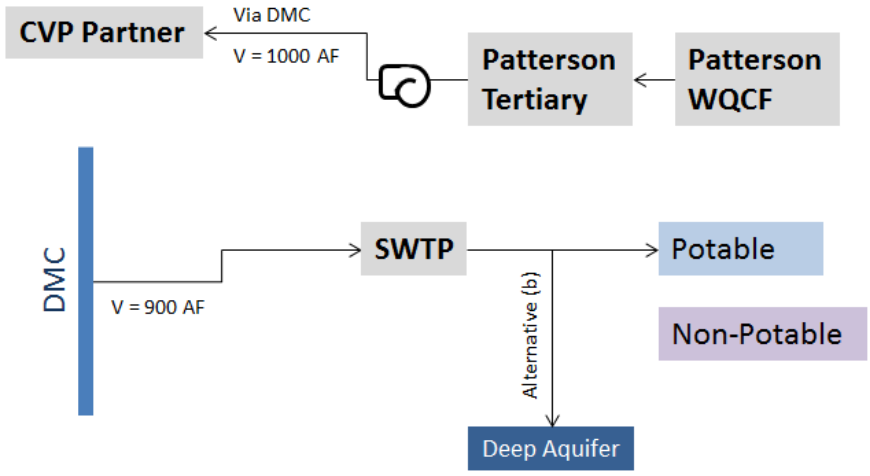


Table 4-6: Cost Estimate for Central Valley Project Contractor Water Exchange

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Pump (WQCF to DMC)	$3,294,000 ($258,600)
Forcemain (WQCF to DMC)	$11,366,000 ($113,660)
Wheeling Cost for DMC	$ -- ($30 / AF * 5,600 AFY = $168,000)
Intake on DMC	$135,000 ($1,350)
Gravity Main (intake to SWTP)	$972,000 ($9,700)
SWTP (and system hookup)	$27,651,000 ($682,300)
(b) SWTP and Injection Wells	$28,650,000 ($752,500)
(b) Deep Wells	$3,717,000 ($114,000)
(b) Chromium VI Treatment	$12,285,000 ($2,340,000)
(b) RO Membrane Treatment	$25,415,000 ($2,541,000)
(b) RO Brine Disposal	$50,354,000 ($644,500)
Total (a – to distribution system)	**$51.1M ($1,273,700)**
Total (b – to injection wells)	**$139.7M ($6,984,000)**

4.2.6 Exchange with San Joaquin River Partner

The WQCF will be retrofitted for non-potable Title 22 treatment. Then, effluent from the WQCF would be pumped to the service area of a partner with San Joaquin River (SJR) rights for non-potable use in exchange for SJR water to be treated for potable use. Water would be diverted from the SJR to a SWTP for potable use. In option (b), water is diverted from the SJR, treated at the SWTP and then injected to the deep aquifer for future pumping via deep wells. Water is to be exchanged at an estimated 10:9 rate (Patterson recycled water to SJR water). It should be noted that there is some uncertainty regarding the ability to gain regulatory approval to treat SJR water for potable use.

Figure 4-13: San Joaquin River Partner Water Exchange

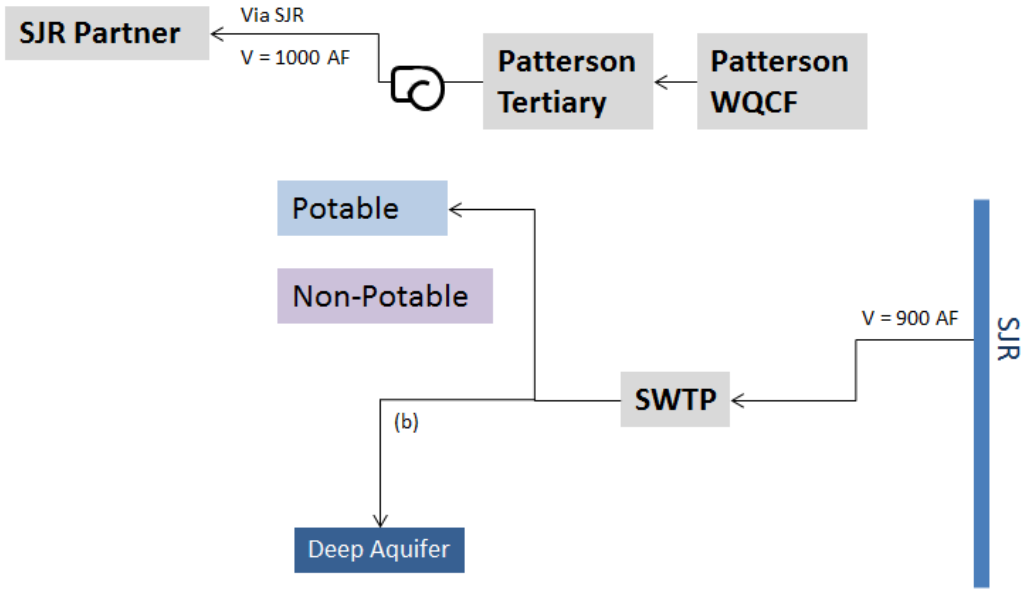


Table 4-7: Cost Estimate for San Joaquin River Partner Water Exchange

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Gravity Main (WQCF to SJR)	$735,000 ($7,350)
Intake on SJR	$194,000 ($1,940)
Gravity Main (SJR intake to SWTP)	$1,299,000 ($12,990)
SWTP (and system hookup)	$30,947,000 ($752,800)
(b) SWTP and Injection Wells	$28,650,000 ($625,500)
(b) Deep Wells	$3,717,000 ($114,000)
(b) Chromium VI Treatment	$12,285,000 ($2,340,000)
(b) RO Membrane Treatment	$25,415,000 ($2,541,000)
(b) RO Brine Disposal	$50,354,000 ($644,500)
Total (a – SWTP to distribution system)	**$40.8M ($815,000)**
Total (b – SWTP to injection wells)	**$130.3M ($6,455,000)**

4.2.7 Patterson Direct Potable Reuse

In this option, the WQCF would be expanded and upgraded to advanced water treatment to produce drinking water for direct potable reuse in Patterson.

In addition to the planned WQCF capacity expansion, the plant should also be expanded to treat wastewater to drinking water standards using reverse osmosis technology with zero-liquid discharge brine disposal. The plant should be able to facilitate the projected flows of 5 mgd.

Figure 4-14: Patterson Direct Potable Reuse

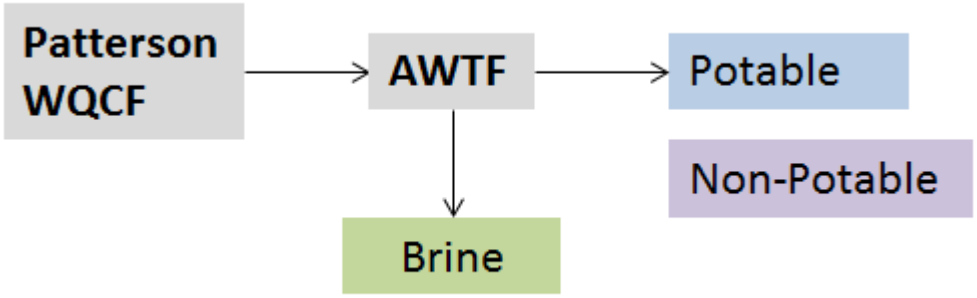


Table 4-8: Cost Estimate for Patterson Direct Potable Reuse

Project Component	Capital Cost (O&M)
AWTF	$32,153,000 ($1,415,000)
Brine Disposal	$6,195,000 ($3,275,000)
Pump Station (AWTF to distribution system)	$1,565,000 ($90,400)
Force Main (AWTF to distribution system)	$5,391,000 ($53,910)
Total	**$45.3M ($4,835,000)**

4.2.8 Long Term Water Transfers

The City of Patterson can negotiate a long-term contract with a district or city with significant water rights to purchase water made available by them. To illustrate the infrastructure and routing required for a long-term transfer, a contract with Oakdale Irrigation District will be used as an example.

Oakdale Irrigation District (OID) has about 50,000 – 60,000 AFY of available supply (based on firm supply reliability). The City would purchase roughly 6,590 AFY (at a cost of about $93/AF). This flow was selected to approximately match the yield of other supply options in this report but could be much larger in reality. Water would then be transferred from OID to Patterson via the Stanislaus River, San Joaquin River, Banta Carbona Canal and the DMC with a conveyance loss of 15% (10% from the Stanislaus and San Joaquin Rivers and 5% from the DMC). This results in a delivery of 5,600 AFY. Water from the SJR would be diverted to a SWTP for treatment and then potable use.

Figure 4-15: Long Term Water Transfers

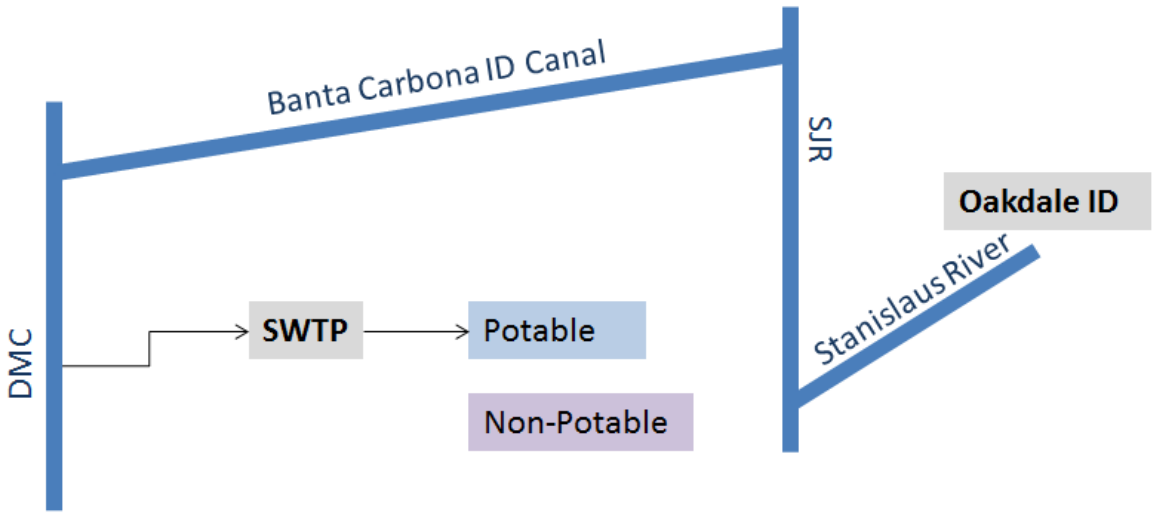


Table 4-9: Cost Estimate for Long-Term Water Transfers

Project Component	Capital Cost (O&M)
Water Purchase	$ -- ($93 / AF * 6,590 AFY = $612,870)
Wheeling Cost for Banta Carbona	$ -- ($100 / AF * 5,930 AFY = $560,000)
Wheeling Cost for DMC	$ -- ($30 / AF * 5,930 AFY = $177,900)
Intake on DMC	$159,000 ($1,590)
Gravity Main (DMC intake to SWTP)	$972,000 ($9,720)
SWTP (and system hookup)	$34,025,000 ($841,000)
Total	**$35.2M ($2,236,000)**

4.2.9 Additional Groundwater Pumping

The existing capacity of the City of Patterson is 7,500 AFY, though only about 4,500 AFY is currently being utilized. The City will construct additional groundwater wells to increase its pumping capacity (deemed a viable supply option by the results of the OYS discussed in Section 4.1).

Figure 4-16: Additional Groundwater Pumping

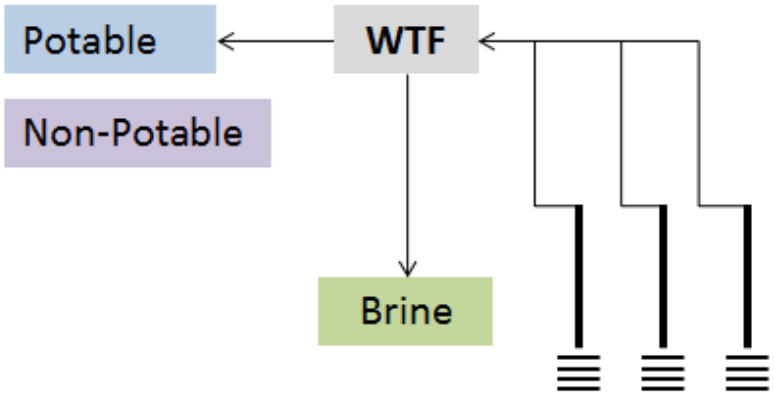


Table 4-10: Cost Estimate for Additional Groundwater Pumping

Project Component	Capital Cost (O&M)
Additional Deep Wells	$5,175,000 ($163,500)
Chromium VI Treatment	$9,100,000 ($2,600,000)
RO Membrane Treatment	$28,238,000 ($2,824,000)
RO Brine Disposal	$50,574,000 ($673,400)
Total	**$93.6M ($6,270,000)**

4.2.10 Conservation

The City could implement several conservation measures in a variety of combinations. Estimated water savings for the City ranges from 700 AFY to 1,800 AFY based on conservation tactics implemented by other agencies throughout California. Examples of conservation programs include:

- Residential water surveys to identify possible areas of waste
- Toilet, washing machine, dishwater, etc. replacement rebates
- Updated plumbing codes
- Require hot water on demand

Table 4-11: Cost Estimate for Conservation

Project Component	Capital Cost (O&M)
Conservation Measures	$2.7M - $37.0M
Total	**$2.7M - $37.0M**

4.2.11 New Shallow Wells near the San Joaquin River to Serve Non-Potable Demand

The City of Patterson would build new shallow pumps near the San Joaquin River to take advantage of natural shallow recharge, supplying non-potable water.

Figure 4-17: New Shallow Wells near the San Joaquin River to Serve Non-Potable Demand

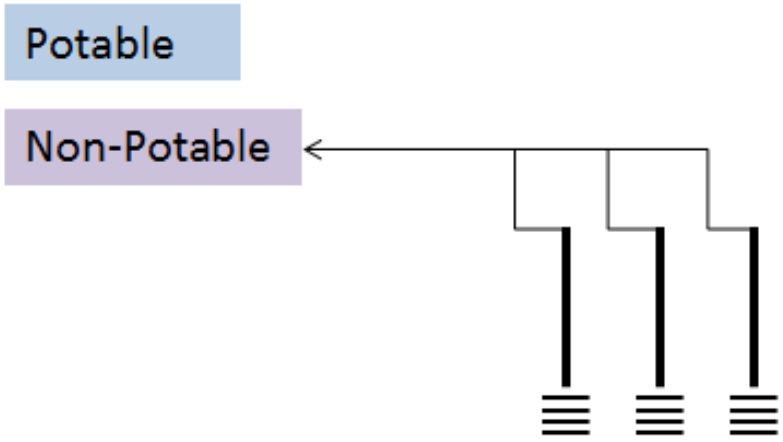


Table 4-12: Cost Estimate for New Shallow Wells near the San Joaquin River

Project Component	Capital Cost (O&M)
Additional Shallow Wells	$5,445,000 ($189,000)
Pump at Wells	$4,568,000 ($417,600)
Force Main (Wells to consumers)	$7,152,000 ($71,520)
Total	**$17.2M ($678,000)**

4.2.12 Recharge and Treat Shallow Aquifer for Potable Use

The WQCF will be retrofitted to treat water to non-potable Title 22 standards after which the effluent will be pumped to infiltration ponds (to be constructed) near the existing non-potable wells. In addition to pumping from the existing wells, new shallow wells will be constructed to meet the potable water supply. Water pumped from these shallow wells will be treated with RO membranes to remove the TDS and then pumped to the distribution system.

Figure 4-18: Recharge and Treat Shallow Aquifer for Potable Use

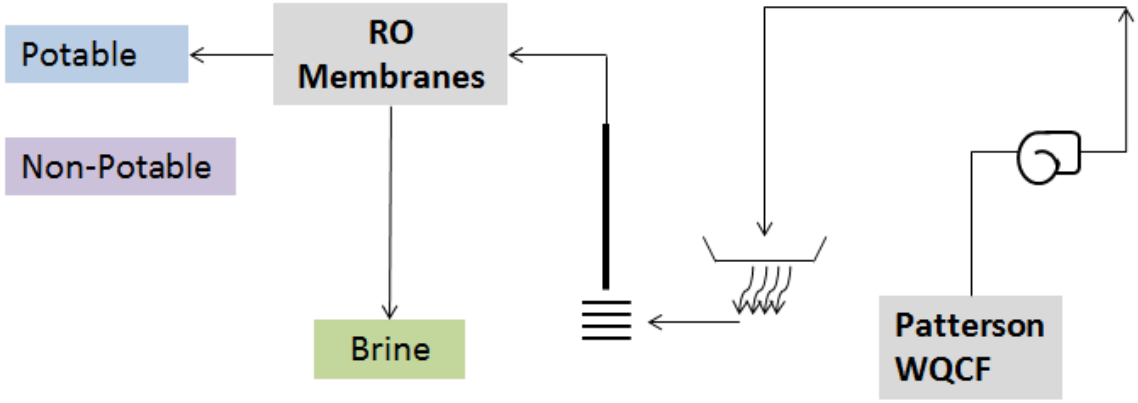


Table 4-13: Cost Estimate for Recharge and Treatment of the Shallow Aquifer for Potable Use

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Pump at WQCF	$4,568,000 ($417,600)
Force Main (WQCF to ponds)	$7,152,000 ($71,520)
Land Acquisition	$600,000 ($ -)
Infiltration Ponds	$13.2 ($600,000)
Shallow Wells	$5,400,000 ($188,000)
RO Membrane Treatment	$28,238,000 ($2,824,000)
RO Brine Disposal	$50,574,000 ($673,000)
Chromium VI Treatment	$7,280,000 ($2,080,000)
Pump at Treatment Site	$431,000 ($19,600)
Force Main (Treatment site to system)	$1,353,000 ($13,530)
Total	**$126.5M ($6,928,000)**

4.2.13 Exchange for Well Use

The WQCF will be retrofitted for non-potable Title 22 treatment. Then, effluent from the WQCF would be pumped to the service area of a nearby user currently pumping from the deep aquifer. In exchange for the water, the City would be granted use of an existing deep aquifer well from which to pump and treat water for potable use. It is assumed that the existing well will need to be replaced once during the project lifetime. Water is to be exchanged at an estimated 10:9 rate (Patterson recycled water to withdrawn groundwater water).

To illustrate a potential alternative exchange, a partnership with Patterson Irrigation District (PID) will be used as an example. In this alternative, water could be transported to PID via the PID canal in exchange for the use of one of their potable (deep) wells.

Figure 4-19: Exchange for Well Use

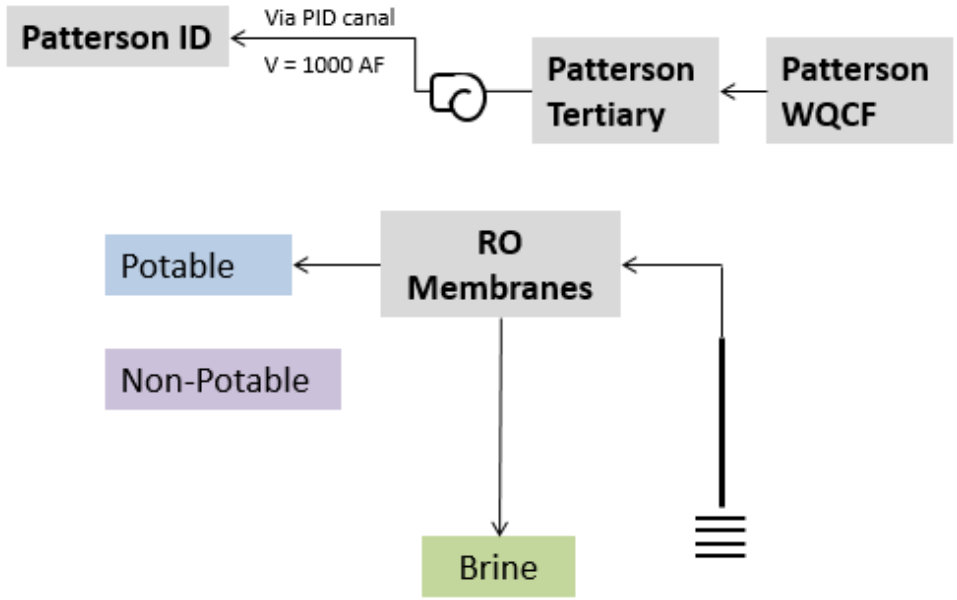


Table 4-14: Cost Estimate for Exchange for Well Use

Project Component	Capital Cost (O&M)
WQCF Retrofit	$7,650,000 ($40,000)
Pump at WQCF	$276,000 ($13,500)
Force Main (WQCF to PID)	$260,000 ($2,600)
Deep Wells Reconstruction	$3,450,000 ($109,000)
Chromium VI Treatment	$8,190,000 ($2,340,000)
RO Membrane Treatment	$25,415,000 ($2,541,000)
RO Brine Disposal	$50,354,000 ($644,500)
Pump at PID Well	$1,356,000 ($74,600)
Force Main (PID Well to system)	$5,771,000 ($57,700)
Total	**$102.7M ($5,823,000)**

4.2.14 Supply Option Summary

A summary of the conceptual supply options and preliminary cost estimates are provided in Table 4-15.

Table 4-15: Supply Option Cost Summary

Option	Yield (AFY)	Cost ($M)	O&M ($ / yr)	Unit Cost ($ / AF)
NVRRWP	5,320	$42.0M	$1.4M	$600
Non-Potable Reuse	5,040	$38.6M	$1.3M	$590
Stormwater Recharge	1,700	$7.8M	$0.33M	$380
Exch SWP (a)	4,788	$51.6M	$1.3M	$750
Exch SWP (b)	4,788	$144.4M	$6.9M	$2,640
Exch CVP (a)	4,788	$51.1M	$1.3M	$740
Exch CVP (b)	4,788	$143.8M	$7.0M	$2,630
Exch SJR (a)	4,536	$40.8M	$0.82M	$590
Exch SJR (b)	4,536	$130.3M	$6.4M	$2,540
Direct Potable Reuse	3,990	$45.3M	$4.8M	$1,500
Long-Term Transfers OID	5,600	$35.2M	$2.2M	$620
Additional Wells	5,600	$93.6M	$6.3M	$1,700
Conservation	700 – 1,800	$2.7M - $18.8M	-	$200 - $1,050
New Non-Potable Wells	5,600	$17.2M	$0.68M	$250
Treat and Replenish Shallow Aquifer	4,480	$126.5M	$6.9M	$2,600
SJR Exchange (Well Exchange)	5,040	$102.7M	$5.8M	$1,910

Chapter 5 Criteria and Supply Analysis

5.1 Supply Option Criteria

As part of the supply portfolio development, the supply options, detailed in Chapter 4, were evaluated based on various criteria and their relative importance. In addition to project cost, supply options were evaluated based on the following criteria:

- Groundwater Sustainability: Assessment of the impacts to the local and regional groundwater sustainability, especially as it relates to requirements established by SGMA.
- Time to Implement: Assessment of the estimates of time to implement all the projects associated with the supply options, including planning, interagency agreements, preliminary design and environmental documentation, permitting, design and construction.
- Environmental constraints and/or impacts: Assessment of the challenges to implement the option without significant impacts to the environment and the mitigation that may be necessary for any impacts
- Regulatory Feasibility: Assessment of the challenges and requirements to obtain all permits required for the supply option, excluding considerations related to SGMA, which are measured in a separate criterion
- Institutional Complexity: Assessment of the level of engagement, participation and cooperation of other agencies in the implementation of the supply option, including obtaining the water

All options have been scored under each of the criteria listed above, based on the understanding of the issues and complexities associated with each supply option. The scores for each option were discussed with the City and are presented in Table 5-1. Scores in the table correspond to a scale where the highest number represents best performance (most sustainable for groundwater use, fastest to implement, fewer environmental concerns, higher regulatory feasibility and lower institutional complexity). The lowest number represents the worse performance (greater strain on groundwater basin, longer time to implement, more environmental concerns, more regulatory issues, more institutional complexity).

Supply options are color coded based on mutually exclusive groups as follows:

- Purple – supply option relies on City wastewater effluent
- Blue – supply option relies on stormwater capture
- Yellow – supply option relies on a water purchase
- Green – supply option relies on conservation
- Orange – supply option relies on groundwater pumping

For example, the City cannot use its wastewater effluent for both non-potable reuse and participation in the North Valley project (colored purple).

Table 5-1: Supply Option Criteria Scoring

Name[1]	Groundwater Sustainability Scale: 1 to 5[2,3]	Time to Implement Scale: 1 to 5[2]	Environment Constraints Scale: 1 to 3[2]	Regulatory Feasibility Scale: 1 to 3[2]	Institutional Complexity Scale: 1 to 5[2]
1 North Valley RRWP	3	3	2	1	3
2 Patterson RW for NPR	3	3	2	3	5
3 Stormwater Capture	4	3	2	2	4
4 Exchange with SWP	3	2	2	1	3
5 Exchange with CVP	3	2	2	1	3
6 Exchange with SJR	3	2	2	1	4
7 Patterson DPR	3	1	2	2	4
8 Long-Term Transfer	3	3	2	2	2
9 Increased GW Pumping	1*	5	2	2	4
10 Conservation	3	5	3	3	5
11 New shallow GW for NP	1*	5	3	2	4
12 Treat Shallow Aquifer	1*	5	3	2	4
13 SJR Exchange *(Well Exchange)*	2	3	3	3	4

Notes:

1. Supply options are color coded by mutually exclusive groups:

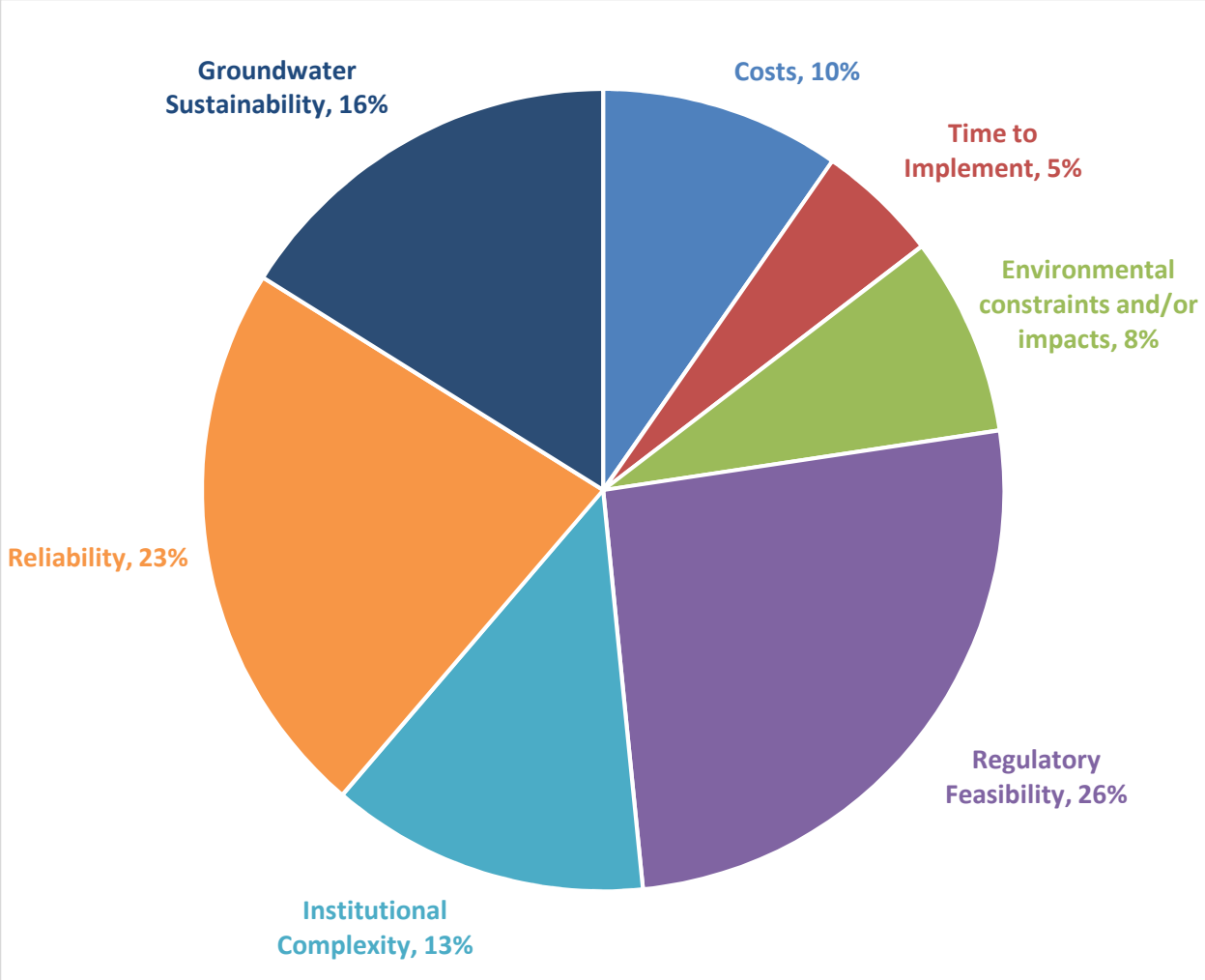
Relies on Recycled Water	Water Purchase	Groundwater	Conservation	Stormwater

2. Criteria scores – 3, or 5 (see scales) = Best; 1 = Worst
3. **Increased the score to 2 in an alternative ranking sensitivity runs*

5.2 Supply Option Analysis

Independent of the supply option scores, the City was asked to weight the importance of each criteria relative to the rest. The average response of multiple City representatives is presented in Figure 5-1. While the cost criterion has a specific weight assigned for the initial ranking of supply options, additional cost considerations have been used in the definition of a feasible and sustainable supply portfolio and the definition of an implementable CIP.

Figure 5-1: Criteria Weighting



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Chapter 6 Supply Portfolio Development

6.1 Supply Gap

To determine the volume of water that each portfolio must supply—the supply gap—the City's existing supply was subtracted from their future demands. Having already determined the buildout (and incremental) demand projections, the existing capacity of the City's groundwater wells in addition to those wells which would likely be put into service in the near future were assessed. The City's current wells can supply approximately 4,000 AFY of potable and 270 AFY of non-potable water. The City also anticipates one potable and one non-potable well (each with about 1,032 AFY in capacity) coming online within the next few years. The supply gap was then calculated by subtracting the baseline supply (existing supply plus expected near-term wells, equal to 5,032 AFY of potable and 1,302 AFY of non-potable) from the projected demand. The supply gap was split between non-potable and potable demand to more accurately tailor supply portfolios to the City's needs. The supply gap for each five-year increment is presented in Table 6-1.

Table 6-1: Supply Gap Projections Through 2050

	2020	2025	2030	2035	2040	2045	2050
Potable Average Annual Demand (AFY)	6,139	7,359	8,578	9,798	11,017	12,237	13,456
Baseline Potable Supply (AFY)	5,032	5,032	5,032	5,032	5,032	5,032	5,032
Potable Supply Gap (AFY)	**1,107**	**2,326**	**3,546**	**4,765**	**5,985**	**7,204**	**8,424**
Conservation (AFY)	143	286	429	571	714	857	1,000
Potable Supply Gap after Conservation (AFY)	**964**	**2,041**	**3,117**	**4,194**	**5,271**	**6,347**	**7,424**
Non-Potable Average Annual Demand (AFY)	1,302	1,517	1,731	1,945	2,159	2,374	2,588
Non-Potable Supply (AFY)	1,302	1,302	1,302	1,302	1,302	1,302	1,302
Non-Potable Supply Gap (AFY)	**0**	**214**	**429**	**643**	**857**	**1,071**	**1,286**

6.2 Ranking of Supply Options

The scores and weights discussed in Chapter 5 were entered into a decision support tool (Criterium Decision Plus (CDP) software) to rank supply options. To further assess the different supply options and confirm the accuracy of the supply rankings, the CDP software was run for multiple criteria weighting and scoring scenarios. CDP was run using the standard scoring presented in Table 5-1 and the weights submitted by each individual City representative (three different runs), an average of those weights (Figure 5-1), and an equal weight applied to each criteria (14% applied to each criteria). Lastly, the Groundwater Sustainability score was increased by one for those supply options marked with an asterisk in Table 5-1 and run with the average City response weights to evaluate the ranking's sensitivity to the groundwater sustainability score (which was difficult to assign given uncertainties regarding SGMA). The combination of base and sensitivity runs is presented in Table 6-2. The various CDP runs did not significantly change the supply rankings, so the initial run (using the average criteria weights) was used to define the supply option tiers.

Table 6-2: Based and Sensitivity Runs for Options Ranking

	Criteria Weights		
Scores	**Individual Weights (3 Runs)**	**Average Weight of Three Individuals**	**Equal Weight for All Criteria**
Base	Sensitivity	Base Run	Sensitivity
Improved Groundwater Sustainability Score for Pumping Options	Sensitivity	Sensitivity	Sensitivity

Figure 6-1 shows the number of times that each supply option was ranked in the top three by the CDP results and illustrates how the different CDP runs did not significantly change the supply option rankings. A screenshot of the CDP output for the standard criteria scores and average weights is shown in Figure 6-2.

Figure 6-1: Occurrence of Supply Option in the Top 3 of CDP Run Results

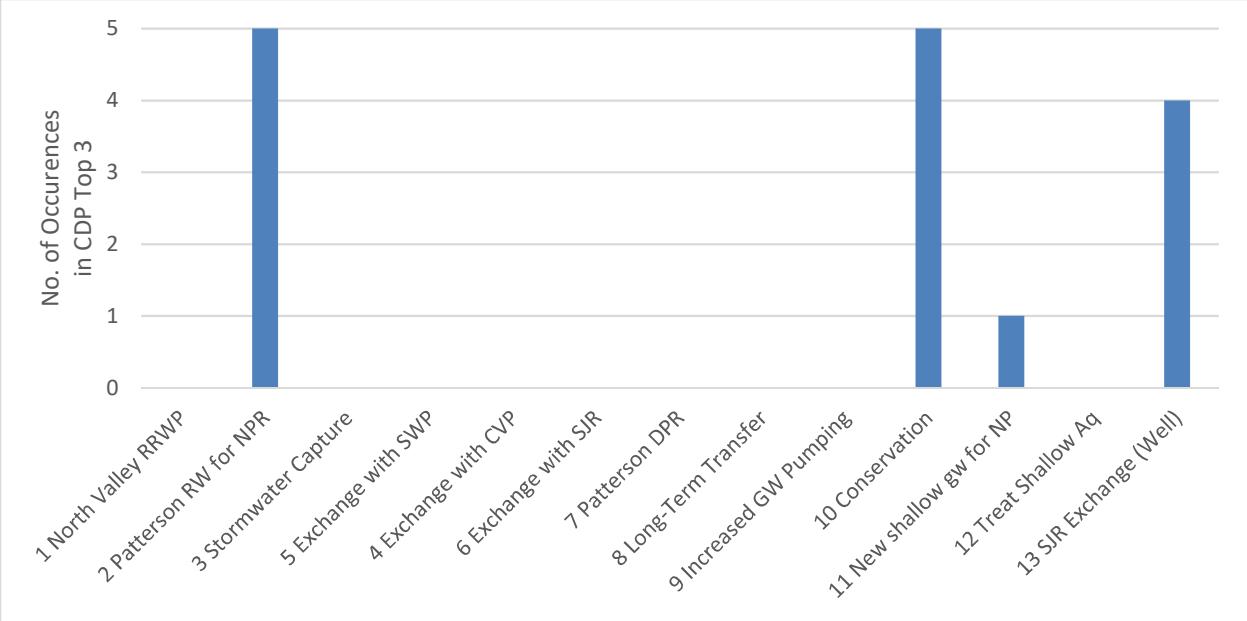
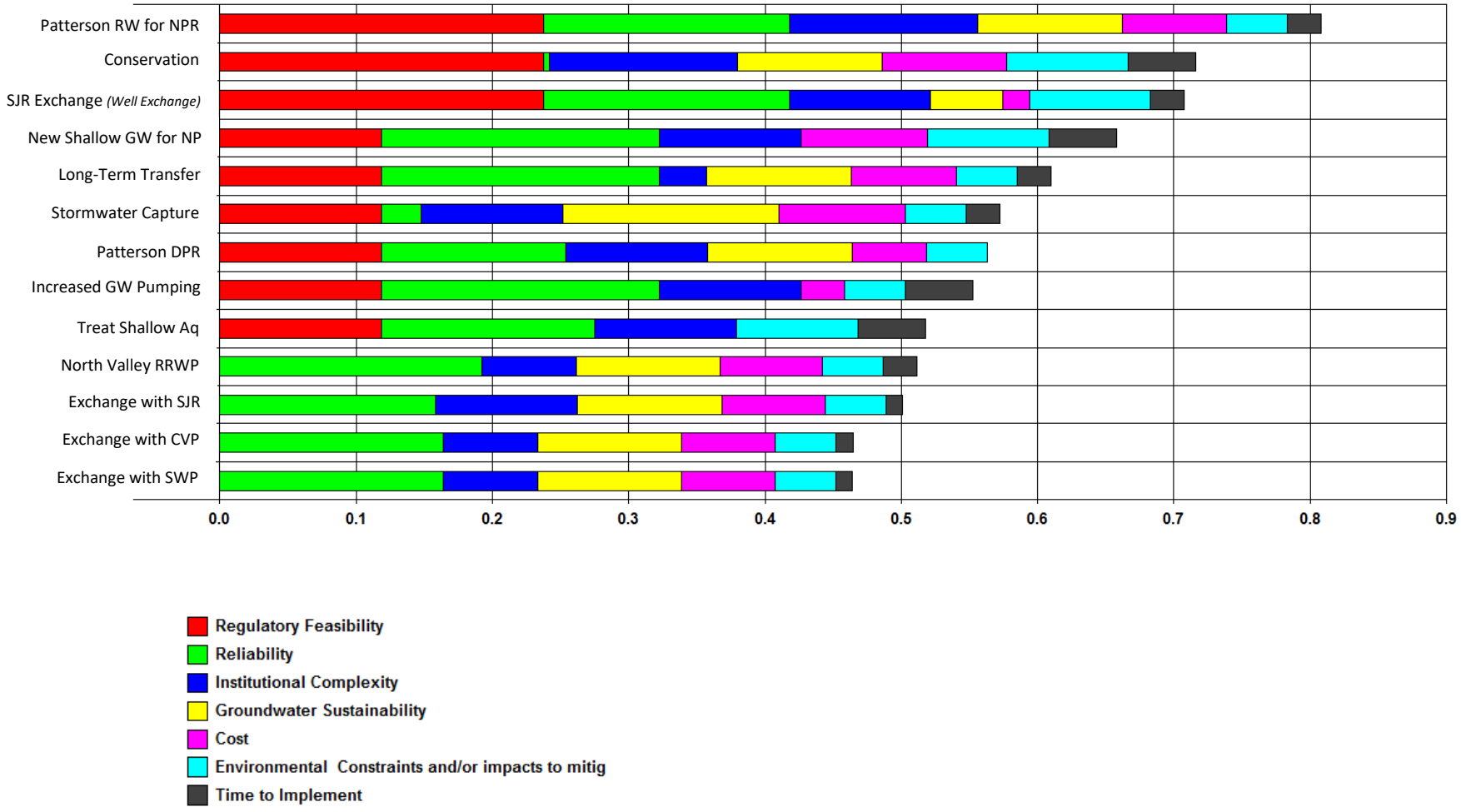


Figure 6-2: Criterium Decision Plus Supply Rankings (for Average Criteria Weights)



6.3 Portfolio Development and Analysis

The supply portfolios were developed using the following approach:

1. Characterize supply options and score and weight them for each criteria.
2. Rank options using the CDP software based upon multiple scoring and weighting scenarios.
3. Define tiers of options based upon CDP rankings.
4. Defined supply gap for potable and non-potable demand. The potable demand did not include system losses and subsequent phases in project implementation will need to define the additional flow from each option or additional conservation levels to account for the small percentage of unaccounted for water in the City's system.
5. Develop portfolios based upon "themes" using supply options from the upper tiers of the rankings. Portfolio "themes" emphasized different traits of supply options that are beneficial for the City.

As discussed in the previous section, supply options were ranked based upon CDP software outputs. Using the CDP results and rankings, tiers of supply options (with the top tier representing the most desirable supply options) were established for use in the development of portfolios. As shown in Figure 6-2, CDP scored supply options on a scale of zero to one and broke out the contribution to the total score by each of the criteria. A threshold was then set for supply option tiers based on the CDP scores using average criteria weights (>0.6 for Tier 1, >0.5 for Tier 2, and everything below 0.5 in Tier 3). These tiers were then checked against the results of the various CDP runs to ensure that the top tier included all of the supply options that ever earned a top three ranking as presented in Figure 6-1

Once the supply options were ranked and the supply gap defined (as discussed in Section 6.1), themes were developed for different portfolio options to emphasize different supply characteristics that are beneficial for the City. The first theme is an emphasis on potable supply, which would ensure that the City could meet any buildout demand in the case that non-potable demands are not able to make the switch off potable water. The next theme focuses on "Patterson controlled" options, which utilize only supply options which do not require local or regional partners. This theme will greatly reduce the institutional complexity of the portfolio. The final theme is an emphasis on minimizing reliance on groundwater. This theme was developed with pending SGMA regulation in mind as a way for the City to expand its supply portfolio and limit the chance of overdrawing the local groundwater basin. These themes are summarized in Table 6-3.

Table 6-3: Portfolio Themes

Theme	Primary Benefit
Potable Emphasis	Can meet all buildout demand in case non-potable demands cannot convert to non-potable supply
Patterson Control	No regional partners required – institutional complexity reduced
Low Reliance on Groundwater	Diversify supply portfolio ahead of SGMA regulations

Portfolios were developed using mutually exclusive supply options (see the color coding in Table 5-1) appropriate to the theme that fell within Tier 1, when possible, or Tier 2. The options were also selected to best fit the potable and non-potable gaps and were scaled from their base yield (as presented in Chapter 5) as necessary. For example, Portfolio No. 2 utilizes "Patterson Recycled Water for Non-Potable Use" which has a base yield of 5,040 AFY, however there is only a non-potable supply gap of around 1,300 AFY.

Therefore, that supply option was scale to approximately 30% of its original yield (and capital cost) to provide the necessary non-potable supply.

One portfolio was created for each of the themes with an additional portfolio created under the "Low Reliance on Groundwater" theme. The two portfolios under the groundwater theme (No. 3 and No. 4) were created to provide different levels of groundwater use reduction. The four portfolios are presented in Table 6-4 through Table 6-7 and include a breakdown of the groundwater use, for SGMA considerations, and potable offset, for SB X7-7 per capita target considerations as well as the projected per capita water use in gallons per capita per day (gpcd).

Table 6-4: Supply Portfolio No. 1 – Potable Emphasis

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 1 (Potable Emphasis)	**9,415**	**$133.9**	**$1,539**
13 SJR Exchange *(Well Exchange)*	5,040	$102.7	$2,124
10 Conservation	1,275	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
9 Increased GW Pumping	1,400	$24.4	$1,701
Total Potable Offset	*1,032*		
Total Groundwater Use for Potable	*8,455*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,802*		

Per Capita Use (gpcd)
181

Table 6-5: Supply Portfolio No. 2 – Patterson Control

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 2 (Patterson Control)	**9,472**	**$99.0**	**$1,111**
2 Patterson RW for NPR	1,512	$11.6	$585
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
9 Increased GW Pumping	4,480	$79.6	$1,701
Total Potable Offset	*2,544*		
Total Groundwater Use for Potable	*11,815*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Table 6-6: Supply Portfolio No. 3 – Low Reliance on Groundwater (1)

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 3 (Less Reliance on GW 1)	**9,472**	**$42.7**	**$519**
8 Long-Term Transfer	4,872	$30.6	$622
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
11 New shallow gw for NP	1,400	$4.3	$247
Total Potable Offset	*2,432*		
Total Groundwater Use for Potable	*7,055*		
Total Groundwater Use for NP	*2,432*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Table 6-7: Supply Portfolio No. 4 – Low Reliance on Groundwater (2)

	Portfolio Yield (AFY)	CAPEX ($M)	Unit Cost ($/AF)
Portfolio 4 (Less Reliance on GW 2)	**9,472**	**$49.3**	**$569**
8 Long-Term Transfer	4,760	$29.9	$622
10 Conservation	1,500	$-	$600
3 Stormwater Capture	1,700	$7.8	$378
2 Patterson RW for NPR	1,512	$11.6	$585
Total Potable Offset	*2,544*		
Total Groundwater Use for Potable	*7,055*		
Total Groundwater Use for NP	*1,032*		
Total Groundwater Recharge	*1,700*		
Total Supply	*15,859*		

Per Capita Use (gpcd)
158

Portfolio Performance

As discussed in the previous section, the portfolios were constructed using supply options from Tier 1, when possible, and Tier 2. The average score of the options used in the portfolios fell above the Tier 1 threshold (0.6) for each portfolio and each portfolio utilized at least two of the Tier 1 options. Of the four portfolios, only Portfolio No. 1 (Potable Emphasis) did not meet the City's 2020 water use goal (160 gpcd).

Based upon the results of the OYS, which indicated that the City could pump in the range of 10,000 – 12,000 AFY, the portfolios were constructed to avoid impacting their current groundwater pumping infrastructure and without significantly impacting the use of groundwater resources in the area surrounding Patterson's sphere of influence.

A summary of the portfolios including the CDP scores of supply options used, groundwater usage and compliance with the City's SB X7-7 target is presented in Table 6-8.

Table 6-8: Portfolio Performance

Portfolio		Average CDP Score of Supply Options	Total Groundwater Use (AFY)	SB X7-7 Compliant (2020 Target)	Capital Cost ($M)	Unit Cost ($/AF)
No. 1	Potable Emphasis	0.64	13,925	No	129.2	1,564
No. 2	Patterson Control	0.66	12,245	Yes	94.3	1,121
No. 3	Low Reliance on Groundwater (1)	0.64	9,165	Yes	42.0	513
No. 4	Low Reliance on Groundwater (2)	0.68	7,765	Yes	47.3	567

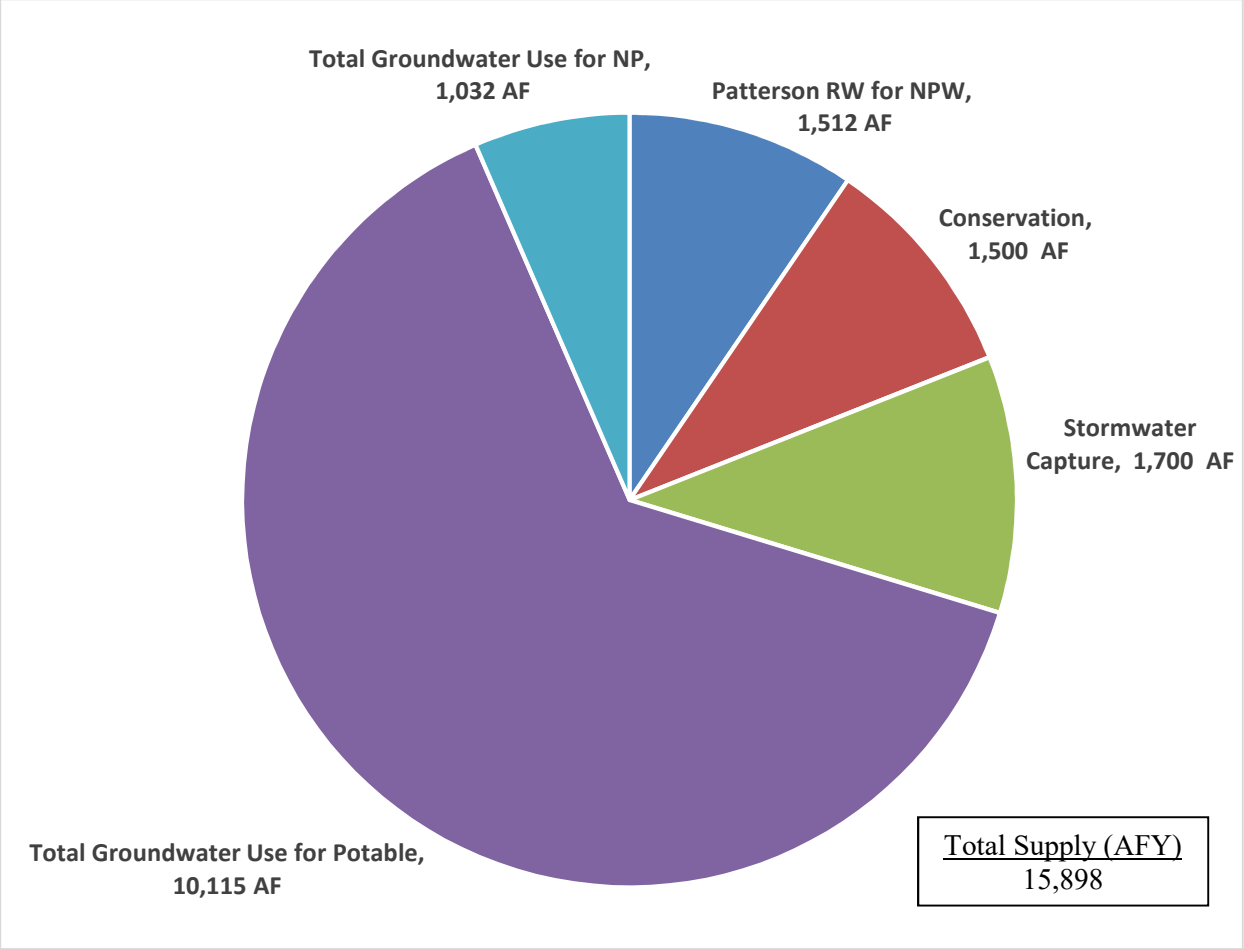
6.4 Selection of Final Portfolio

Based upon an analysis of the portfolio performance, two portfolios were recommended: No. 2 – Patterson Control and No. 4 – Low Reliance on Groundwater (2). Portfolio No. 2 was recommended because it offers the City independent control of its water supply and easier implementation of water supply projects. The complexity of partnering with regional agencies has the potential to add additional costs not captured in the estimates of the capital expenditure and operations and maintenance of the supply options. Portfolio No. 4 was recommended as it offers the City the least reliance on groundwater in the face of uncertain SGMA regulation. This supply option draws a volume of water well under the operational yield presented in Section 4.1.2.

Using the information and analysis discussed in previous sections of this report, the City held meetings to discuss their preferred portfolio. After deliberation, the City selected Portfolio No. 2 – Patterson Control, as its preferred portfolio. Figure 6-3 shows the supply mix for the City at buildout demand conditions.

The City recognizes that the selected portfolio may need to be revisited as SGMA-related plans are developed and put into effect or if the predicted yields or feasibility of any projects within the portfolio are determined to be significantly different during additional pre-design analyses.

Figure 6-3: Supply Mix After Implementation of Preferred Portfolio (Portfolio 2 "Local Control")



Notes:

1. The "Total Groundwater Use for Potable" is equal to the "Total Groundwater Use for Potable" (11,815 AFY) less the volume attributed to "Stormwater Capture" (1,700 AFY).

Chapter 7 Hydraulic Analysis

The City's previous hydraulic model was last updated in 2008 and was not fully documented, providing little information as to the basis for input data including physical characteristics of water facilities, allocation and distribution of demands, and facility operational information. Based on conversations with the City, it was understood that the model was never calibrated and did not run properly when it was completed. Because of these limiting facts and thus the inability to verify the accuracy of the data, an exploratory task was conducted to provide an understanding of the adequacy and completeness of the City's 2008 hydraulic model. The findings were the basis for updating the hydraulic model for the purposes of master plan efforts as detailed in the following sections.

7.1 Hydraulic Model Update and Refinement

Based on the result of the exploratory task and as part of this master plan, the following tasks were completed to better understand the City's hydraulic system and update the model:

- Develop a system profile schematic as shown in Figure 7-1.
- Convert the model to an Innovyze InfoWater™ model.
- Incorporate missing water facilities including all tanks, wells, pipelines, and pressure reducing valves per City's latest information.
- Update key water facilities operations characteristics per discussions with City staff.
- Add/update pipelines installed since 2008.
- Update demands globally based on new information regarding existing demands and demand projections (Chapter 3).
- Calibrate the model based on flow meter and pressure data.

7.2 Assessment of the Existing System

7.2.1 Hydraulic Criteria

Hydraulic criteria for the City's distribution system were developed based on the Water Supply Analysis for the General Plan Update (2010) and discussions with the City. The hydraulic design criteria remained largely the same as those presented in the previous planning work with minor changes to the maximum allowed delivery pressure, peak hour velocity and fire flow requirements. Updates to the fire flow requirements were made with consultation from the Patterson Fire Marshall. The hydraulic criteria used during analysis of the City's distribution system is presented in Table 7-1.

7.2.2 Distribution System Assessment

Once the existing system network was updated and calibrated, the model was run to identify existing deficiencies based on the hydraulic criteria. Model runs were set up to evaluate peak hour conditions and fire scenarios at all the hydrants around the City[6]. The peak hour condition simulations identified some max velocity concerns, primarily in the older portion of the system, near City Hall, due to the use of 2-inch mains. Fire flow scenarios triggered multiple instances of pressure deficiencies.

A list of near-term projects was developed to address the existing deficiencies identified by the peak hour and fire flow scenarios. These projects were compiled by creating a new model network and adjusting pipeline diameters until all deficiencies were addressed. A map of pipes needing to be upsized to address

[6] City operations personal were consulted to ensure that pump station controls were accurately represented for the fire scenarios and the correct booster pumps were triggered.

existing deficiencies is presented in Figure 7-2. A model network with the mitigation projects incorporated was used as the baseline for system expansion.

Table 7-1: Hydraulic Design Criteria

Description	Value	Units
System Pressures		
Maximum	95	psi
Maximum at service connection	80	psi
Maximum at service connection	40	psi
during Peak hour	30	psi
during fire flow	20	psi
Pipeline Velocity		
Peak Hour	5 - 7	fps
Maximum Day plus Fire	10	fps
Pipeline Headloss		
Pipe diameter <16 inches	5 - 10	feet / 1,000 ft
Pipe diameter >= 16 inches	2 - 3	feet / 1,000 ft
Storage Volume		
Operational	0.3 x MDD	MG
Emergency	0.5 x MDD	MG
Fire[1]	Max FF rate x duration	MG
Fire Fighting Requirements[2]		
Residential- Low and Medium Density (2 hrs.)	1,000	gpm
Residential- Other developments (2 hrs.)	2,000	gpm
Residential- High Density (2 hrs.)	2,500	gpm
Commercial all types (4 hrs.)	3,500	gpm
Light and Heavy Industrial (4 hrs.)	4,500	gpm
Public/Quasi-Public (4 hrs.)	3,500	gpm
Peaking Factors[3]		
PHD/MDD	1.6	--
MHD/MDD	0.4	--
MDD/ADD	1.8	--

Notes:

1. Largest required flow in pressure zone
2. Based on the 2010 Water Supply Analysis for General Plan Update Report and updated per discussion with City and Fire Department (11/15/16)
3. AWWA Water Demand Basis below. Values at 50% of typical ranges observed in distribution system of various size
4. Acronyms:
    a. ADD = Average Annual-day demand
    b. MDD = Maximum-day demand
    c. PHD = Peak-hour demand
    d. MHD = Minimum-hour demand
    e. FFD = Fire-flow demand

Figure 7-1: System Profile Schematic

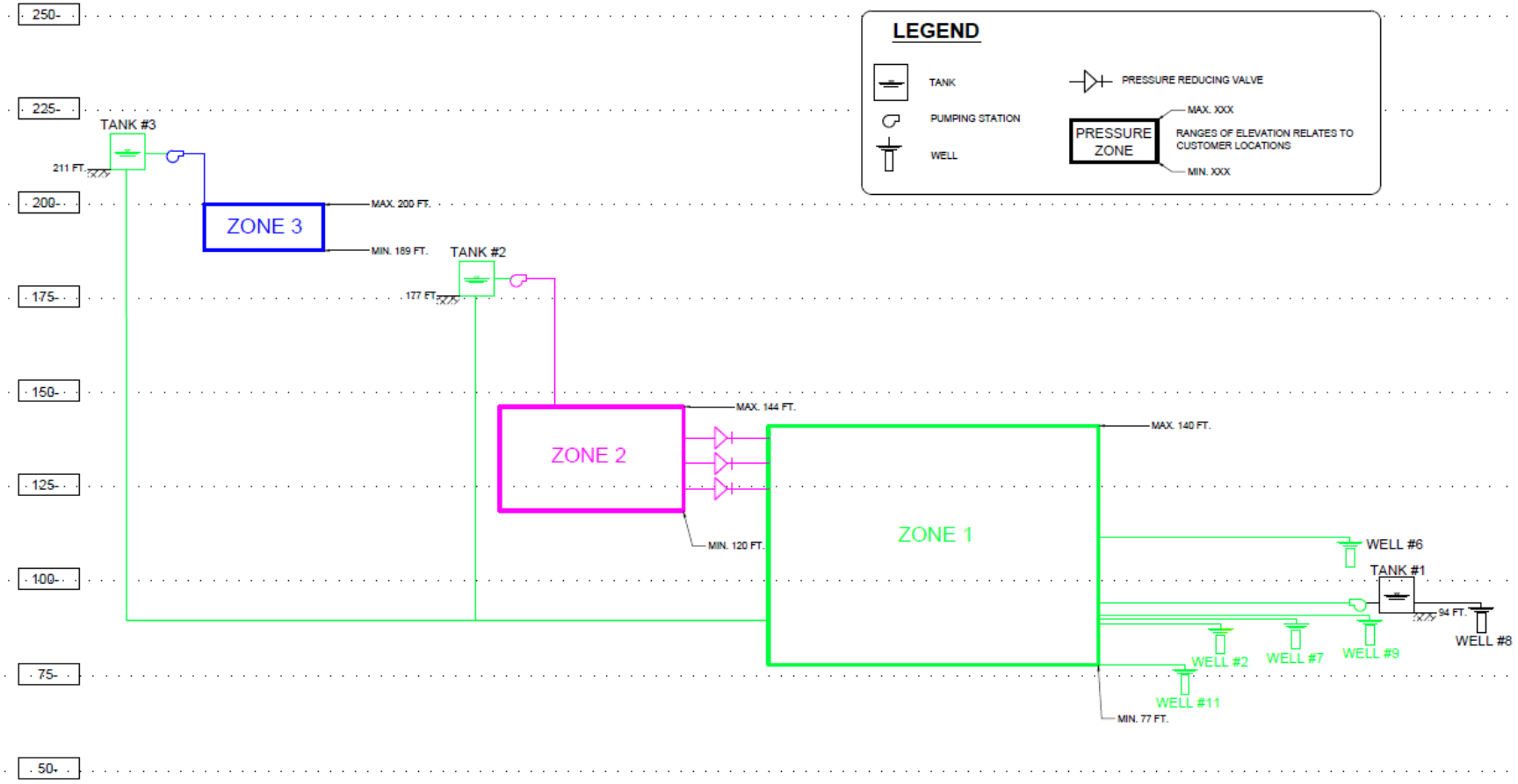
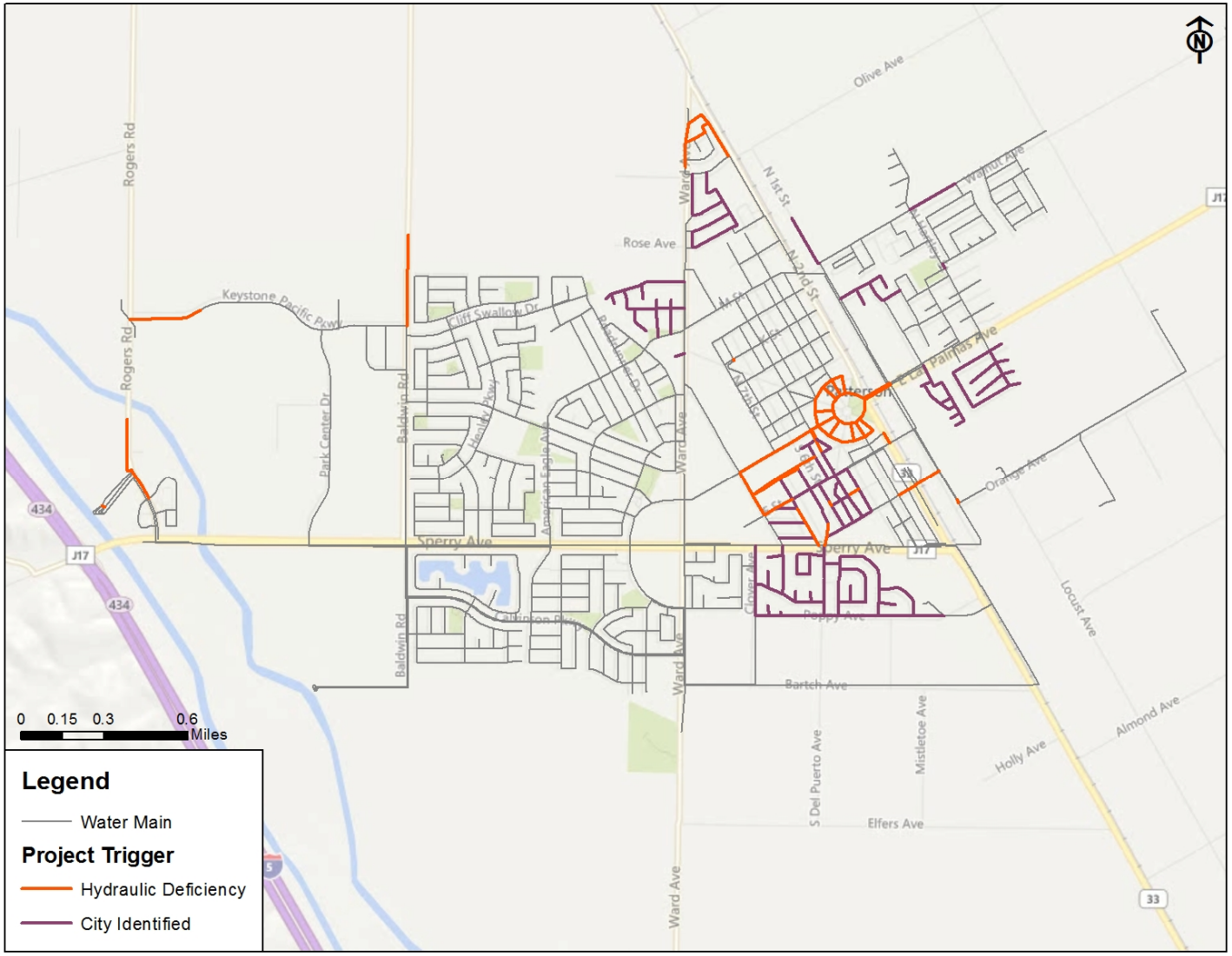


Figure 7-2: Existing Deficiency Mitigation Projects



7.2.3 Storage Assessment

In parallel to the distribution system assessment, an assessment of the required storage was completed. Using the criteria shown in Table 7-1, the required storage for each pressure zone was calculated with the total storage requirement equaling the sum of the operational, emergency and fire storage for each zone. Existing storage was calculated based on the existing storage tanks and groundwater storage credit for each existing well. Groundwater storage credits were calculated by multiplying the capacity of the well by the duration of a fire event (4 hours). This is a standard formula for assigning groundwater storage credits. The existing storage (the sum of the tank volume and groundwater storage credit) was subtracted from the required storage to determine the storage deficiency for each zone. This analysis determined that Zone 1 does not have a storage deficiency while Zone 2 and Subzone 3 have deficiencies of 2 MG and 1 MG, respectively. A summary of the existing system storage analysis is presented in Table 7-2.

Table 7-2: Existing System Storage Analysis

Zone	Max Day Demand (MGD)	Operational Storage Required (MG)[1]	Emergency Storage Required (MG)[2]	Fire Storage Required (MG)[3]	Total Storage Required (MG)	Existing Storage (MG)	GW Storage (MG)[4]	Deficiency (MG)
Z1	5.05	1.50	2.50	1.25	5.25	3.50	1.75	0.00
Z2	1.21	0.25	0.75	1.00	2.00	0	0	2.00
Subzone 3	0.10	0.00	0.00	1.00	1.00	0	0	1.00

Notes:
1. Operational storage requirement = max day demand * 30%
2. Emergency storage requirement = max day demand * 50%
3. Fire storage requirement = max fire flow requirement * duration (4 hours)
4. Groundwater storage = total capacity of wells feeding zone * fire flow durations (4 hours)

7.3 System Expansion

7.3.1 Development Review and Distribution System Expansion

Prior to development of an expanded distribution system, development plans and the General Plan were reviewed to determine future demand distribution and phasing. As described in Chapter 3, buildout land use designations were used to calculate future demands, however, more specific demands were used for those developments with individual demand studies as presented in Table 7-3.

Using more specific development plans in addition to City notes, parcel development phasing was determined and consolidated into GIS for use in the model expansion. A map of the parcel development phasing—for near-term, 5-year, 10-year and buildout—is included in Appendix E. Using this map, future pipes were routed along existing roads and likely road extensions to best serve future development areas. Once the pipe routing was completed wells, tanks and pumps were added to the model. Pipelines and other facilities were designated for an implementation phase based on the surrounding parcel development phase and the hydraulic needs of the system (e.g. the creation of a system loop by including a pipeline in the 5-year instead of 10-year plan).

Table 7-3: Specific Development Plan Information

Development Name	Area (acre)	Total Number of Units	Projected Potable Demand (AFY)	Construction Phase
Logistic Center	28.7	--	9.8	5-yr
Western Bridge Park	22.8	--	23	5-yr
Sperry Baldwin SC	1.8	--	5.5	10-yr
Villages of Patterson	582	3100	2,020	5-yr, 10-yr, Buildout
Arambel		--	742	5-yr, 10-yr, Buildout
Baldwin Subdivision		500	328	10-yr
Keystone Ranch		770	200	10-yr
McShane Phase III	17.0	--	5.8	5-yr
Mahaffey Plaza	7.6	--	22.8	5-yr, 10-yr
Patterson Housing	2.0	154	145.1	10-yr

7.3.2 Modeled Future Supply

The City has indicated that the hydraulic system will continue to utilize a combination of ground level storage and variable speed pumps to supply the required pressure into the system. Wells and tanks were added to the model based on this preference, with controls added as necessary to allow for scattered existing and future variable speed pumps to work together. A more detailed analysis of the future pump stations will need to be conducted prior to implementation to ensure proper pump sizing and controls for integration into the existing system.

7.3.3 Storage Assessment

Building on the existing system storage assessment, a similar analysis was conducted for future development phases based on the demand projections discussed in Chapter 3. Changes to the existing storage for each zone is based on anticipated development of new groundwater wells and the associated groundwater storage credit. This analysis does not account for any tanks that would be built to meet existing storage deficiencies. As shown in Table 7-4, new water tanks will need to be constructed in each pressure zone to meet storage requirements as the City expands.

Table 7-4: Future Storage Assessment

Zone	Max Day Demand (MGD)	Operational Storage Required (MG)[1]	Emergency Storage Required (MG)[2]	Fire Storage Required (MG)[3]	Total Storage Required (MG)	Existing Storage (MG)	GW Storage (MG)[4]	Deficiency (MG)[5]
5-Year								
Z1	6.09	1.75	3.00	1.25	6.00	3.50	2.00	0.50
Z2	1.78	0.50	1.00	1.00	2.50	0	0	2.50
Subzone 3	0.14	0.00	0.00	1.00	1.00	0	0	1.00
10-Year								
Z1	6.52	1.75	3.25	1.25	6.25	3.50	2.00	0.75
Z2	2.29	0.75	1.25	1.00	3.00	0	0.25	2.75
Subzone 3	0.14	0.00	0.00	1.00	1.00	0	0	1.00
Buildout								
Z1	9.62	3.00	4.75	1.25	9.00	3.50	2.50	3.00
Z2	6.34	2.00	3.25	1.25	6.50	0	1.75	4.75
Subzone 3	0.22	0.00	0.00	1.00	1.00	0	0	1.00
New Zone	1.66	0.50	0.75	1.00	2.25	0	0	2.25

Notes:

1. Operational storage requirement = max day demand * 30%
2. Emergency storage requirement = max day demand * 50%
3. Fire storage requirement = max fire flow requirement * duration (4 hours)
4. Groundwater storage = total capacity of wells feeding zone * fire flow durations (4 hours)
5. Calculated deficiency by phase assumes that no new tanks are constructed to meet existing deficiency or any preceding development phase condition

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Chapter 8 Capital Improvement Plan

Based on the results of the hydraulic analysis and the projects required for the preferred supply portfolio, a capital improvement plan (CIP) was developed to map out a timeline of expected project implementation and costs.

8.1 Capital Projects Cost Estimates

8.1.1 Capital Improvement Plan Assumptions

The following assumptions were made during the preparation of capital improvement project cost estimates:

- Each individual project details the cost estimate using 2016 dollars.
- Projects and the cost estimates prepared for this CIP were prepared at a planning level. Exact alignments and facilities required should be reassessed during the design phase at which point a more specific cost estimate should be prepared. Cost estimates presented in this CIP are assumed to be within -30% to +50% of the final project cost.
- It was assumed that future wells will require hypochlorite facilities. A planning level cost estimate for that facility was prepared and included in the estimate for a new well.
- Pipeline lengths are based on the GIS/hydraulic model database
- Service line reconnections are estimated based on the number of adjacent parcels to the water main being replaced.
- One gate valve is required for each 500-foot section of pipe (rounded up).

8.1.2 Unit Cost Sources

The cost estimates for the City's capital improvement utilized unit costs from the following sources:

- Recent City bids
  - CDBG 4th Street Project Phase II
  - The Ward Avenue Waterline Replacement Project
  - Gateway Water Tank Recoating
- Previous City cost estimates (Water Supply Analysis, 2010)
- Vendor estimates
- Recent RMC experience with similar projects
- The RS Means cost database

8.1.3 Cost Estimate Methodology

Unit costs were applied as follows:

1. When applicable, unit costs from the recent City bids were applied to CIP projects. These unit costs were determined by averaging the unit costs provided by multiple contractors to account for different bidding techniques.
2. For those items which were included in City bids, but were not the same size as those required in the CIP project (e.g. pipelines or valves), a "Patterson Adjustment Factor" was calculated by comparing bid costs to RS Means costs for similarly sized items (e.g. 8-inch pipe) and then applied to RS Means unit costs for missing sizes (e.g. 16-inch pipe) to estimate an appropriate Patterson unit cost.

3. If bid information was not available, a unit cost was determined based on RS Means data (adjusted for project location and timing) or recent RMC experience with similar projects (where available and appropriate)

8.2 New Supply Projects

Based on the preferred supply portfolio as described in Section 6.4, projects were developed for the selected future water supplies: new groundwater wells, stormwater capture and tertiary treated recycled water.

New groundwater wells are anticipated to be constructed roughly every five years to meet growing City demands. These wells will draw from the sub-Corcoran aquifer and will require chlorine dosing at the well site.[7] New wells can be developed near the existing wellfield, in the western portion of the City, or in a new wellfield in the northwest of the City. For this planning document, it has been assumed that one future well will be developed in the existing wellfield and additional wells (estimated at five through buildout) will be constructed in the northwest of the City. Each well will have a capacity of roughly 1,500 gpm, providing around 1,000 AFY of potable supply. The exact siting of each new well will be determined based on future siting and yield analyses and a review of potential impacts in compliance with regulations.

In addition to new wells, percolation ponds will be constructed as part of the stormwater capture alternative. In total, the ponds are expected to cover roughly 14 acres. Sizing of the percolation ponds was based on existing infiltration rate data and may be updated pending results of further field investigation including a siting study and pilot test. The percolation pond project can be phased so that the ponds are constructed over a few years, allowing for the gradual increase of aquifer recharge capacity.

The final supply project will be the addition of tertiary filtration to the existing WQCF to produce non-potable effluent suitable for irrigation around the City. The treated effluent will be incorporated into the City's existing non-potable distribution system. This project will provide around 1.4 mgd (1,600 AFY) of non-potable supply for the City. The new supply projects are summarized in Table 8-1. Detailed cost estimates for each project can be found in Appendix F.

[7] Pending future regulations, Chromium VI treatment may also be required at the well site before distribution. Possible treatment options include reduction-coagulation-filtration, weak base anion exchange, strong base anion exchange and reverse osmosis.

Table 8-1: New Supply Projects Through Buildout

Project ID	Project Phase	Project Description	Cost Estimate (2016 $s)
WL-1	10-year	Develop a new well-field in the northwest of the City and construct one well feeding pressure zone 2. The well is assumed to have a capacity of roughly 1,500 gpm.	$3,062,000
WL-2	Buildout	Construct new well in existing well-field in the eastern portion of the City, serving pressure zone 1. The well is assumed to have a capacity of roughly 1,500 gpm.	$3,062,000
WL-3	Buildout	Construct four new wells in the well-field in the northwest of the City feeding into pressure zone 2. Each well is assumed to have a capacity of roughly 1,500 gpm.	$11,499,000
PP-1	5-year	Construct percolation ponds to capture and infiltrate stormwater from Del Puerto Creek. The ponds will cover roughly 14 acres.	$7,476,000
TT-1	10-year	Add tertiary filtration to the WQCF to produce 1.4 mgd of treated water for non-potable reuse.	$1,951,000
Total			**$27,050,000**

8.3 Existing System Improvement Projects

Based on the results of the existing system assessment discussed in Section 7.2, improvement projects were developed to address the identified deficiencies. These projects address insufficient fire flow and maximum velocity hydraulic triggers. Additionally, City staff identified several projects to replace pipes and service connections nearing the end of their useful life. Existing system improvement projects are summarized in Table 8-2 and illustrated in Figure 8-1 to Figure 8-5. Detailed cost estimates for each project can be found in Appendix F.

Table 8-2: Near-Term Capital Improvement Projects

Project ID	Project Type	Project Description	Cost Estimate (2016 $s)
WM-1A	Water Main	Replace approximately 6,880 lf of existing pipe with 3,250 lf of 6-inch pipe, 2,320 lf of 8-inch pipe and 1,310 lf of 10-inch pipe and the connecting service lines. Additionally, replaced 20 service lines located along Clover Ave.	$2,210,000
WM-1B	Water Main	Replace approximately 10,300 lf of existing pipe with 790 lf of 6-inch pipe, 6,100 lf of 8-inch pipe and 3,380 lf of 10-inch pipe.	$3,283,000
WM-2	Water Main	Replace 4,240 lf of existing pipe with 4-inch. 6-inch, 8-inch, 10-inch, 12-inch and 16-inch pipe	$1,500,000
WM-3	Water Main	Replace 2,660 lf of existing pipe with 8-inch pipe and replace service lines along additional 2,000 lf of pipe (around 40 additional service lines)	$924,000
WM-4	Water Main	Replace about 5,000 lf of existing pipe with 2,500 lf of 6-inch pipe and 2,500 lf of 8-inch pipe.	$1,587,000
WM-5	Water Main	Replace 200 lf of existing 6-inch pipe, upsize 910 lf of pipe to 10-inch and install 120 lf of new 6-inch pipe.	$401,000
WM-6A	Water Main	Replace around 10,180 lf of existing pipe with 4, 6, and 8-inch pipe	$2,743,000
WM-6B	Water Main	Replace around 17,750 lf of existing pipe with 4, 6, 8 and 10-inch pipe and install around 1,000 lf or new 6 and 8-inch pipe.	$5,163,000
WM-7	Water Main	Replace around 150 service lines along 5,600 lf of existing pipe	$258,000
WM-8	Water Main	Replace 3,050 lf of existing pipe with 6-inch pipe (diameter to be confirmed).	$768,000
WM-9	Water Main	Upsize 1,730 lf of existing pipe with 12-inch pipe and install 70 lf of new 12-inch pipe	$682,000
WM-10	Water Main	Upsize 1,820 lf of existing pipe with 10-inch main and 740 lf with 12-inch pipe and install 220 lf of new 12-inch main.	$982,000
WM-11	Water Main	Upsize 1,730 lf of existing pipe with 12-inch pipe and upsize 1,390 lf with 16-inch pipe.	$1,366,000
Total			**$21,867,000**

8.4 5-Year Capital Improvement Plan

As discussed in Section 7.3, the hydraulic model was used to expand on the existing system to accommodate future development. The 5-year project list was developed based on development plans and results of the hydraulic model. Projects for the 5-year CIP include a new storage tank, recoating of existing tanks, a new pump station and new potable and non-potable water mains to serve new customers. A summary of the 5-year capital improvement projects is presented in Table 8-3 and illustrated in Figure 8-1 to Figure 8-5. Detailed cost estimates for each project can be found in Appendix F.

Table 8-3: 5-Year Capital Improvement Projects

Project ID	Project Type	Project Description	Cost Estimate (2016 $s)
ST-1	Storage Tank	New 1.0 MG Storage Tank (Zone 3)	$1,763,000
WT-1	Tank Recoating	Re-coat Storage Tank (Zone 1)	$338,000
WT-3	Tank Recoating	Re-coat Storage Tank (Zone 3)	$338,000
WM-ST-0	Water Main	New pipeline to serve the new Zone 2 (Arambel) tank.	$1,177,000
PS-0	Pump Station	Add a pump station to pressure zone 2 at the new Zone 2 (Arambel) tank to meet demand/pressure requirements.	$1,444,000
WM-12	Water Main	Install 810 lf of new 10-inch pipe and 7,740 lf of new 12-inch pipe	$4,172,000
WM-13	Water Main	Install 5,250 lf of new 12-inch pipe.	$1,576,000
WM-14	Water Main	Install 2,710 lf of new 12-inch pipe	$2,359,000
WM-15	Water Main	Install 5,540 lf of new 8-inch and 10,500 lf of new 12-inch pipe	$4,808,000
WM-16	Water Main	Install 4,440 lf of new 8-inch pipe, 7,040 lf of new 12-inch pipe and 2,350 lf of new 16-inch pipe.	$3,840,000
NP-1	Water Main	Install 300 lf of new 6-inch 2,500 lf of new 10-inch non-potable pipe	$808,000
NP-2	Water Main	Install 1,060 lf of new 4-inch and 5,900 lf of new 12-inch non-potable pipe	$2,503,000
NP-4	Water Main	Install 7,590 lf of new 8-inch and 2,630 lf of new 10-inch and 1,200 lf of new 12-inch non-potable pipe.	$4,573,000
Total			**$29,699,000**

8.5 10-Year Capital Improvement Plan

As with the 5-year CIP project list, the 10-year project list was developed based on development plans and results of the hydraulic model. Projects for the 10-year CIP include a new storage tanks, recoating of an existing tank, a new pump station and new potable and non-potable water mains to serve new customers. A summary of the 10-year capital improvement projects is presented in Table 8-4 and illustrated in Figure 8-1 to Figure 8-5. Detailed cost estimates for each project can be found in Appendix F.

Table 8-4: 10-Year Capital Improvement Projects

Project ID	Project Type	Project Description	Cost Estimate (2016 $s)
ST-2	Storage Tank	New 1.25 MG Storage Tank (Zone 2)	$2,223,000
WT-2	Tank Recoating	Re-coat Storage Tank (Zone 2)	$372,000
PS-1	Pump Station	Add a pump to pressure zone 2 at the new wellfield tank to meet flow requirements.	$1,444,000
WM-17	Water Main	Install 1,460 lf of new 10-inch pipe	$337,000
WM-18	Water Main	Install 8,080 lf of new 12-inch pipe	$2,548,000
WM-19	Water Main	Install 6,870 lf of new 12-inch pipe.	$3,959,000
WM-20	Water Main	Install 9,140 lf of new 16-inch pipe	$3,755,000
WM-21	Water Main	Install 9,450 lf of new 12-inch pipe and 670 lf of new 16-inch pipe.	$4,557,000
NP-5	Water Main	Install 12,740 lf of new 12-inch non-potable pipe	$4,097,000
NP-6	Water Main	Install 7,910 lf of new 12-inch non-potable pipe to connect non-potable system to the WCQF.	$2,826,000
Total			**$26,118,000**

8.6 Buildout Capital Improvement Plan

Unlike the 5-year and 10-year project plans, the buildout improvement plan was developed without detailed developer plans. Buildout projects were instead developed based on general plan land use data and the demand projections discussed in Chapter 3. While it is assumed that the demand projections developed for this master plan are reasonable for City buildout, at this time it is not known precisely when or where those developments will occur. For this planning effort, storage requirements are assumed to be fairly accurate, while distribution projects will need to be revisited as more detailed development plans are made available. The pipe alignments and pump and tank locations presented in this plan are based on existing street alignments, a review of likely connection points to the hydraulic system and an approximation of where tanks and pumps will be constructed. Placeholder pipe diameters and pump station sizes have been developed based on information available at this time. A summary of the buildout capital improvement projects is presented in Table 8-5 and illustrated in Figure 8-1 to Figure 8-5. Detailed cost estimates for each project can be found in Appendix F.

Table 8-5: Buildout Capital Improvement Projects

Project ID	Project Type	Project Description	Cost Estimate (2016 $s)
ST-BO1	Storage Tank	New 3.0 MG Storage Tank (Zone 1)	$4,091,000
ST-BO2	Storage Tank	New 2.0 MG Storage Tank (Zone 2)	$2,575,000
ST-BO3	Storage Tank	New 2.25 MG Storage Tank (Zone 4)	$2,953,000
PS-BO-1	Pump Station	Add a pump to serve the tank in the new pressure zone (Zone 4) in the western hills.	$1,235,000
WM-BO	Water Main	Install 234,384 lf of new pipe	$69,225,000
NP-3A	Water Main	Install 7550 lf of new 4-inch and 6770 lf of new 8-inch non-potable pipe	$3,093,000
NP-3B	Water Main	Install 2600 lf of new 4-inch non-potable pipe	$519,000
Total			**$83,691,000**

8.7 Capital Improvement Plan Summary

The existing, 5-year, 10-year and buildout project lists were combined to create the complete the master CIP program. Though the cost estimates for each individual project were developed using 2016 dollars, the project summary table (Table 8-6) incorporates inflation to better capture the anticipated project cost and serve as a basis for City rate studies and budgets. The table also includes designations as to whether the project was triggered by existing deficiencies or future system needs. The locations of each project are shown in Figure 8-1 to Figure 8-5.

In the case of project WM-6B, a pipeline replacement was needed due to a hydraulic criteria trigger, however the CIP project includes a pipe sized to serve future demands to eliminate the need to replace and upsize a pipe shortly after its installation. The cost allocated to future system needs is the difference in project cost due to the larger diameter pipe being installed.

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Table 8-6: Capital Improvement Plan Summary

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
ST-1	4	*Existing Need*	20/21	New 1.0 MG Storage Tank (Zone 3)			$1,870,000											$1,870,000	$1,870,000	$0
ST-2	1	*10-year*	24/25	New 1.25 MG Storage Tank (Zone 2)							$2,654,000							$2,654,000	$0	$2,654,000
WT-1	3	*Maintenance*	19/20	Re-coat Storage Tank (Zone 1)		$348,000												$348,000	$348,000	$0
WT-2	4	*Maintenance*	23/24	Re-coat Storage Tank (Zone 2)						$431,000								$431,000	$431,000	$0
WT-3	4	*Maintenance*	18/19	Re-coat Storage Tank (Zone 3)	$338,000													$338,000	$338,000	$0
WM-ST-0	1	*5-year*	19/20	New pipeline to serve the new Zone 2 (Arambel) tank.		$1,212,000												$1,212,000	$0	$1,212,000
PS-0	1	*5-year*	19/20	Add a pump station to pressure zone 2 at the new Zone 2 (Arambel) tank to meet demand/pressure requirements.		$1,487,000												$1,487,000	$0	$1,487,000
PS-1	1	*10-year*	24/25	Add a pump to pressure zone 2 at the new wellfield tank to meet flow requirements.							$1,724,000							$1,724,000	$0	$1,724,000
WL-1	1	*10-year*	24/25	Construct a new well in the northwest portion of the City serving Zone 2.							$3,656,000							$3,656,000	$0	$3,656,000
PP-1	1	*5-year*	23/24	New percolation ponds to capture and recharge stormwater from Del Puerto Creek.			$100,000	$2,723,000	$2,805,000	$2,789,000								$8,417,000	$0	$8,417,000

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
WM-1A	3	*Existing Need*	18/19	Replace approximately 6,880 lf of existing pipe with 3,250 lf of 6-inch pipe, 2,320 lf of 8-inch pipe and 1,310 lf of 10-inch pipe and the connecting service lines. Additionally, replaced 20 service lines located along Clover Ave.	$2,210,000													$2,210,000	$2,210,000	$0
WM-1B	3	*Existing Need*	19/20	Replace approximately 10,300 lf of existing pipe with 790 lf of 6-inch pipe, 6,100 lf of 8-inch pipe and 3,380 lf of 10-inch pipe.		$3,381,000												$3,381,000	$3,381,000	$0
WM-2	2	*Existing Need*	21/22	Replace 4,240 lf of existing pipe with 4-inch. 6-inch, 8-inch, 10-inch, 12-inch and 16-inch pipe				$1,639,000										$1,639,000	$1,068,000	$571,000
WM-3	2	*Existing Need*	20/21	Replace 2,660 lf of existing pipe with 8-inch pipe and replace service lines along additional 2,000 lf of pipe (around 40 additional service lines)			$980,000											$980,000	$980,000	$0
WM-4	2	*Existing Need*	23/24	Replace about 5,000 lf of existing pipe with 2,500 lf of 6-inch pipe and 2,500 lf of 8-inch pipe.						$1,840,000								$1,840,000	$1,840,000	$0
WM-5	2-3	*Existing Need*	18/19	Replace 200 lf of existing 6-inch pipe, upsize 910 lf of pipe to 10-inch and install 120 lf of new 6-inch pipe.	$401,000													$401,000	$401,000	$0
WM-6A	2-3	*Existing Need*	19/20	Replace around 10,180 lf of existing pipe with 4, 6, and 8-inch pipe		$2,825,000												$2,825,000	$2,825,000	$0

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
WM-6B	3	*Existing Need*	22/23	Replace around 17,750 lf of existing pipe with 4, 6, 8 and 10-inch pipe and install around 1,000 lf or new 6 and 8-inch pipe.					$5,811,000									$5,811,000	$5,510,000	$301,000
WM-7	2	*Existing Need*	23/24	Replace around 150 service lines along 5,600 lf of existing pipe						$299,000								$299,000	$299,000	$0
WM-8	2-3	*Existing Need*	35-40	Replace 3,050 lf of existing pipe with 6-inch pipe (diameter to be confirmed).												$1,197,000		$1,197,000	$1,197,000	$0
WM-9	4	*Existing Need*	25/26	Upsize 1,730 lf of existing pipe with 12-inch pipe and install 70 lf of new 12-inch pipe								$839,000						$839,000	$0	$839,000
WM-10	2	*Existing Need*	28-35	Upsize 1,820 lf of existing pipe with 10-inch main and 740 lf with 12-inch pipe and install 220 lf of new 12-inch main.											$1,421,000			$1,421,000	$1,421,000	$0
WM-11	1-2	*Existing Need*	25/26	Upsize 1,730 lf of existing pipe with 12-inch pipe and upsize 1,390 lf with 16-inch pipe.								$1,680,000						$1,680,000	$0	$1,680,000
WM-12	2	*5-year*	21/22	Install 810 lf of new 10-inch pipe and 7,740 lf of new 12-inch pipe				$4,559,000										$4,559,000	$0	$4,559,000
WM-13	1	*5-year*	20/21	Install 5,250 lf of new 12-inch pipe.			$1,672,000											$1,672,000	$0	$1,672,000
WM-14	3	*5-year*	21/22	Install 2,710 lf of new 12-inch pipe				$2,578,000										$2,578,000	$0	$2,578,000
WM-15	1	*5-year*	19/20	Install 5,540 lf of new 8-inch and 10,500 lf of new 12-inch pipe		$4,952,000												$4,952,000	$0	$4,952,000
WM-16	1	*5-year*	20/21	Install 4,440 lf of new 8-inch pipe, 7,040 lf of new 12-inch pipe and 2,350 lf of new 16-inch pipe.			$4,074,000											$4,074,000	$0	$4,074,000
WM-17	2	*10-year*	25/26	Install 1,460 lf of new 10-inch pipe								$414,000						$414,000	$0	$414,000
WM-18	1-2	*10-year*	26/27	Install 8,080 lf of new 12-inch pipe									$3,228,000					$3,228,000	$0	$3,228,000
WM-19	2	*10-year*	26/27	Install 6,870 lf of new 12-inch pipe.									$5,015,000					$5,015,000	$0	$5,015,000

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
WM-20	1, 4	*10-year*	27/28	Install 9,140 lf of new 16-inch pipe										$4,899,000				$4,899,000	$0	$4,899,000
WM-21	1	*10-year*	27/28	Install 9,450 lf of new 12-inch pipe and 670 lf of new 16-inch pipe.										$5,946,000				$5,946,000	$0	$5,946,000
WL-2	3	*Buildout*	28-35	Construct a new well serving Zone 1.											$4,431,000			$4,431,000	$0	$4,431,000
WL-3	1	*Buildout*	28 - After FY 40	Construct 4 new wells in the northwest portion of the City serving Zone 2.											$4,160,000	$4,479,000	$10,384,000	$19,023,000	$0	$19,023,000
ST-BO1	3	*Buildout*	After FY 40	New 3.0 MG Storage Tank (Zone 1)													$7,389,000	$7,389,000	$0	$7,389,000
ST-BO2	4	*Buildout*	After FY 40	New 2.0 MG Storage Tank (Zone 2)													$4,651,000	$4,651,000	$0	$4,651,000
ST-BO3	4	*Buildout*	After FY 40	New 2.25 MG Storage Tank (Zone 4)													$5,333,000	$5,333,000	$0	$5,333,000
PS-BO-1	4	*Buildout*	After FY 40	Add a pump to serve the tank in the new pressure zone (Zone 4) in the western hills.													$2,231,000	$2,231,000	$0	$2,231,000
WM-BO	1-4	*Buildout*	28 - After FY 40	Install 234,380 lf of new pipe											$33,389,000	$35,950,000	$41,676,000	$111,015,000	$0	$111,015,000
TT-1	n/a	*10-year*	24/25	Construct a new tertiary filtration system at the WQCF to produce Title 22 compliant recycled water.							$2,330,000							$2,330,000	$0	$2,330,000
NP-1	3	*5-year*	19/20	Install 300 lf of new 6-inch 2,500 lf of new 10-inch non-potable pipe		$832,000												$832,000	$0	$832,000
NP-2	2	*5-year*	20/21	Install 1,060 lf of new 4-inch and 5,900 lf of new 12-inch non-potable pipe			$2,655,000											$2,655,000	$0	$2,655,000
NP-3A	1-4	*Buildout*	35-40	Install 7,550 lf of new 4-inch and 6,770 lf of new 8-inch non-potable pipe												$4,819,000		$4,819,000	$0	$4,819,000
NP-3B	3	*Buildout*	35-40	Install 2,600 lf of new 4-inch non-potable pipe												$809,000		$809,000	$0	$809,000

Project Number	Map Page No.	Notes	CIP Year	Project Description	Near-Term	5-Year				10-Year					Buildout			Estimated Project Cost	Existing Deficiency / Maintenance Cost	Future System Needs Cost
					FY 18-19	FY 19-20	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-35	FY 35-40	After FY 40			
NP-4	2	*5-year*	22/23	Install 7,590 lf of new 8-inch and 2,630 lf of new 10-inch and 1,200 lf of new 12-inch non-potable pipe.					$5,147,000									$5,147,000	$0	$5,147,000
NP-5	1	*10-year*	23/24	Install 11,290 lf of new 12-inch non-potable pipe						$4,750,000								$4,750,000	$0	$4,750,000
NP-6	2	*10-year*	25/26	Install 7,910 lf of new 12-inch non-potable pipe to connect non-potable system to the WCQF.								$3,476,000						$3,476,000	$0	$3,476,000
Total					**$2,949,000**	**$15,037,000**	**$11,351,000**	**$11,499,000**	**$13,763,000**	**$10,109,000**	**$10,364,000**	**$6,409,000**	**$8,243,000**	**$10,845,000**	**$43,401,000**	**$47,254,000**	**$71,664,000**	**$262,888,000**	**$24,119,000**	**$238,769,000**
Existing Deficiency/Maintenance Total					**$2,949,000**	**$6,554,000**	**$2,850,000**	**$1,068,000**	**$5,510,000**	**$2,570,000**	**$0**	**$0**	**$0**	**$0**	**$1,421,000**	**$1,197,000**	**$0**	**$24,119,000**		

Notes:

1. These costs do not match the detailed cost estimates as this sheet includes a cost escalation factor to account for inflation.
2. Cost to future development is based on the difference in cost between projects addressing existing system deficiencies and those that address the requirements for future system expansion. In those cases where the allocation is greater than 0 but less than 100%, the project includes some pipe replacement upsized to accommodate future demands.

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Figure 8-1: CIP Projects Overview

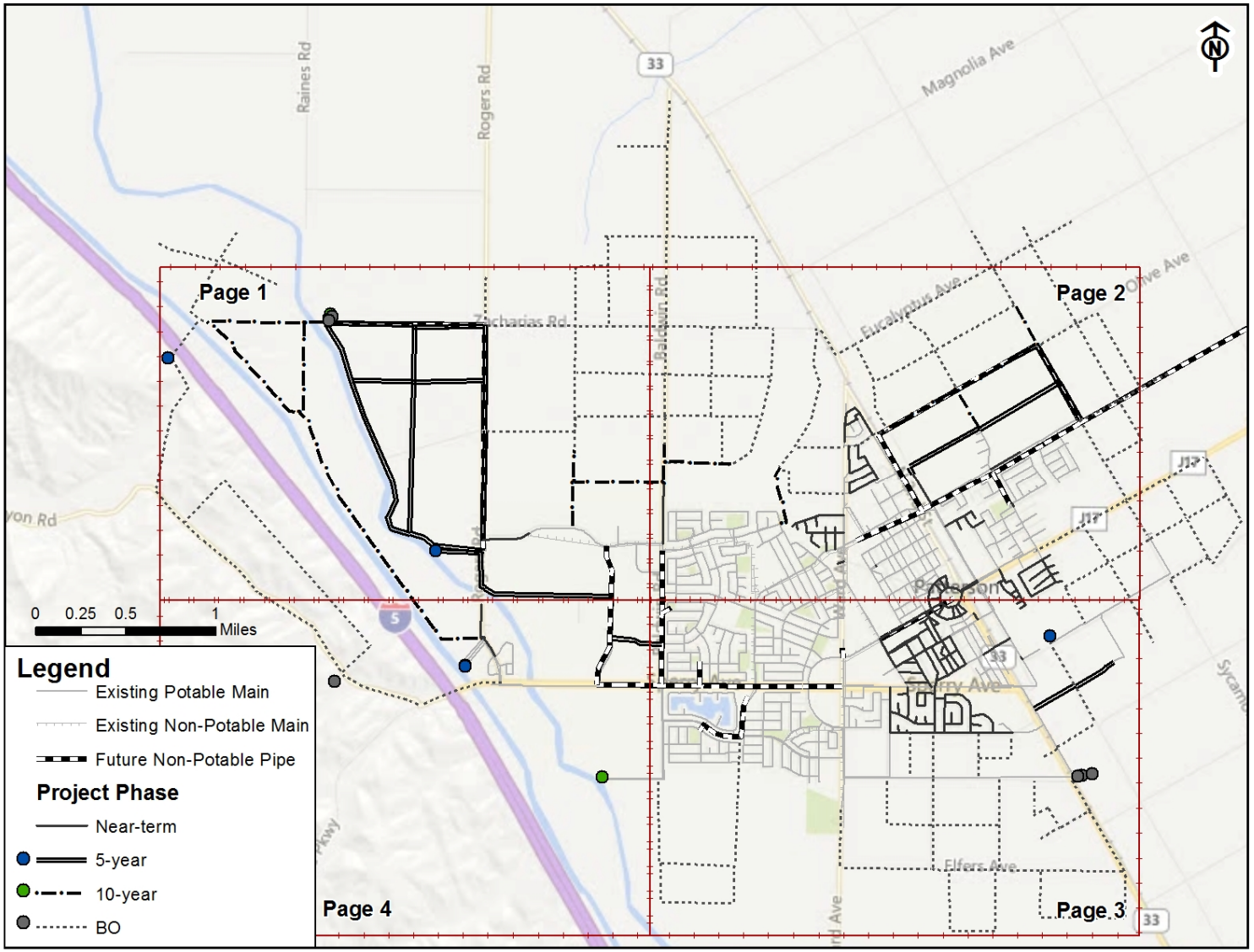

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Figure 8-2: CIP Projects Page 1

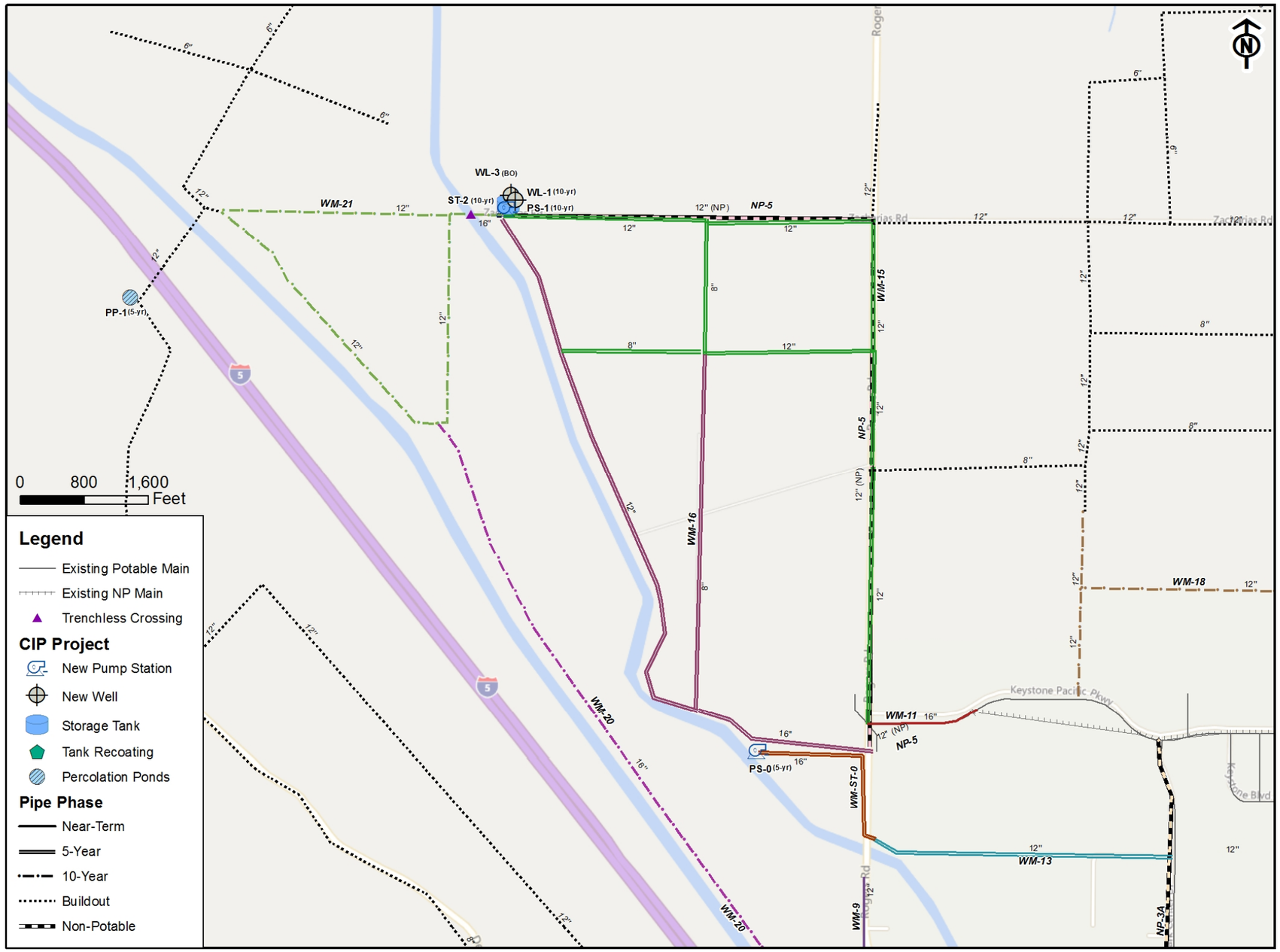


Figure 8-3: CIP Projects Page 2

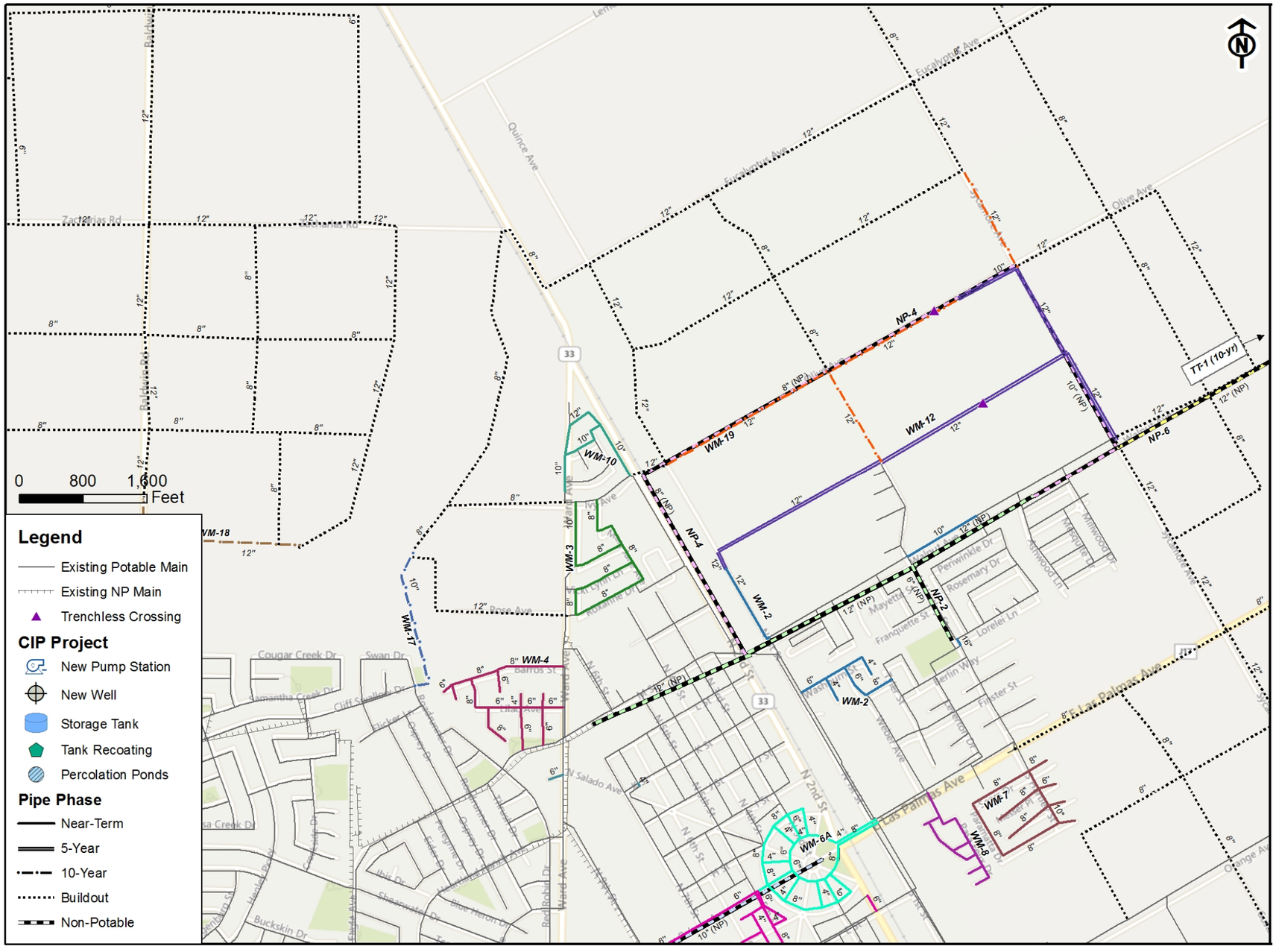


Figure 8-4: CIP Projects Page 3

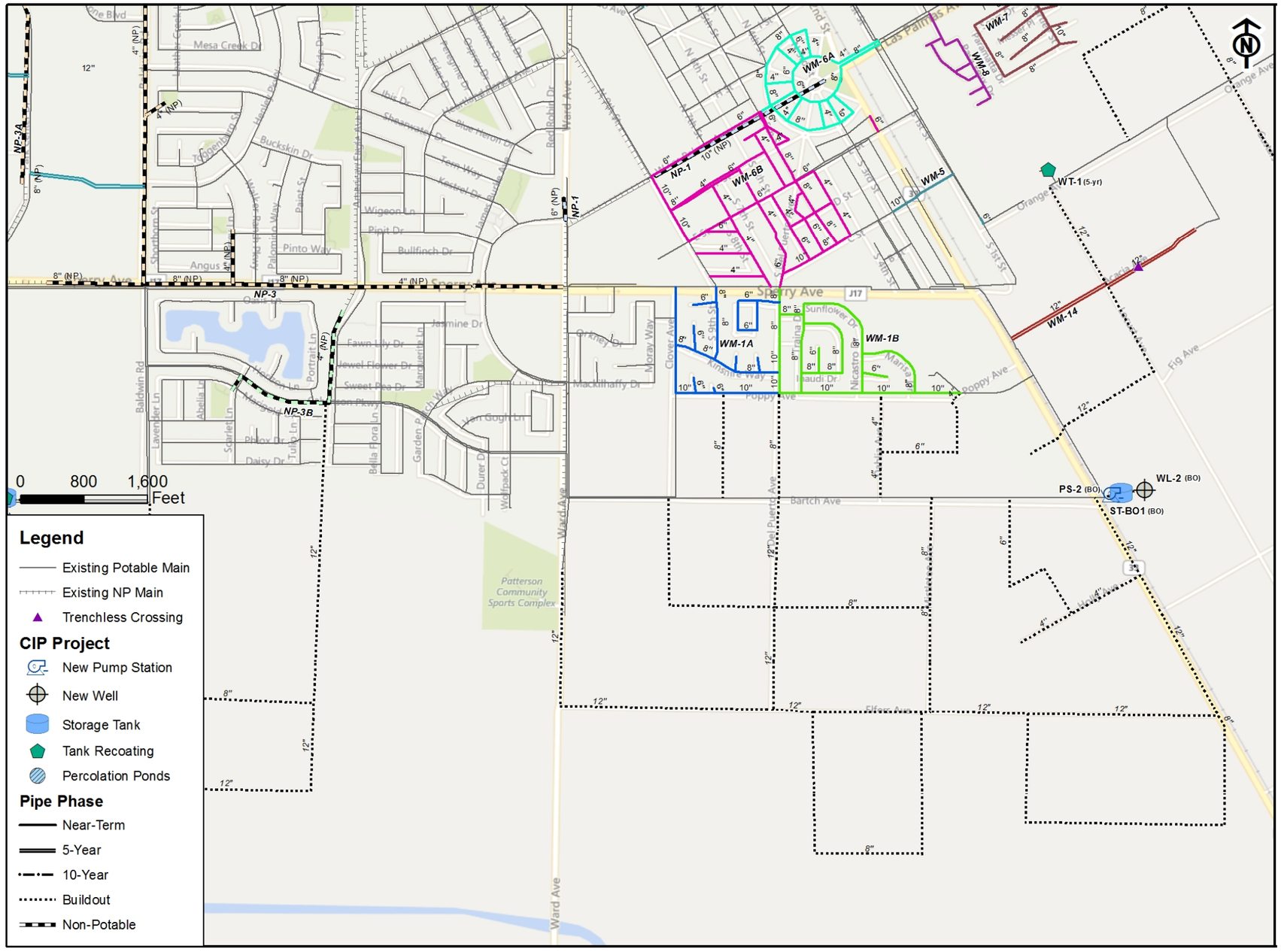
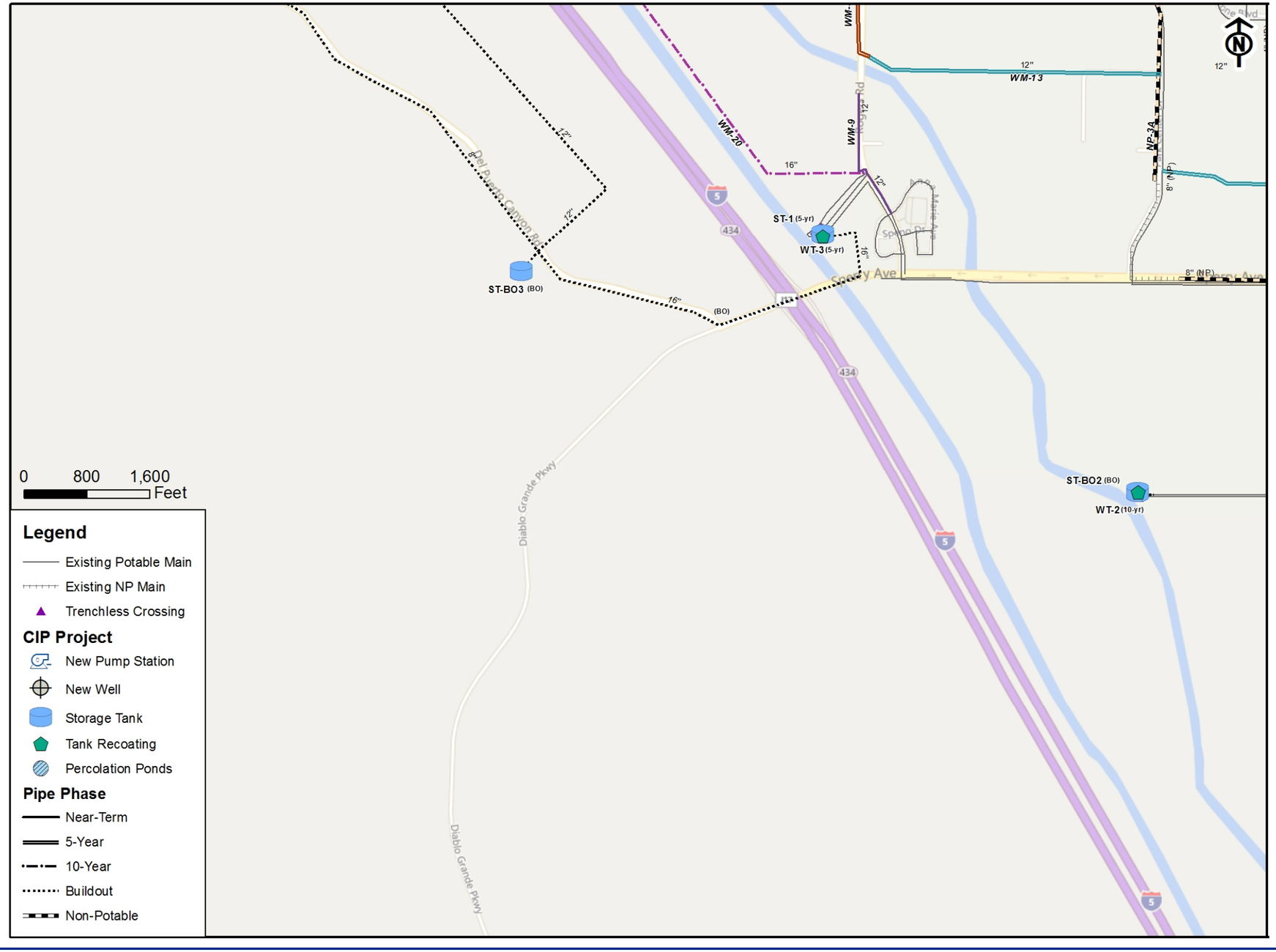


Figure 8-5: CIP Projects Page 4



Chapter 9 Implementation Plan

9.1 Supply Timing and Phasing

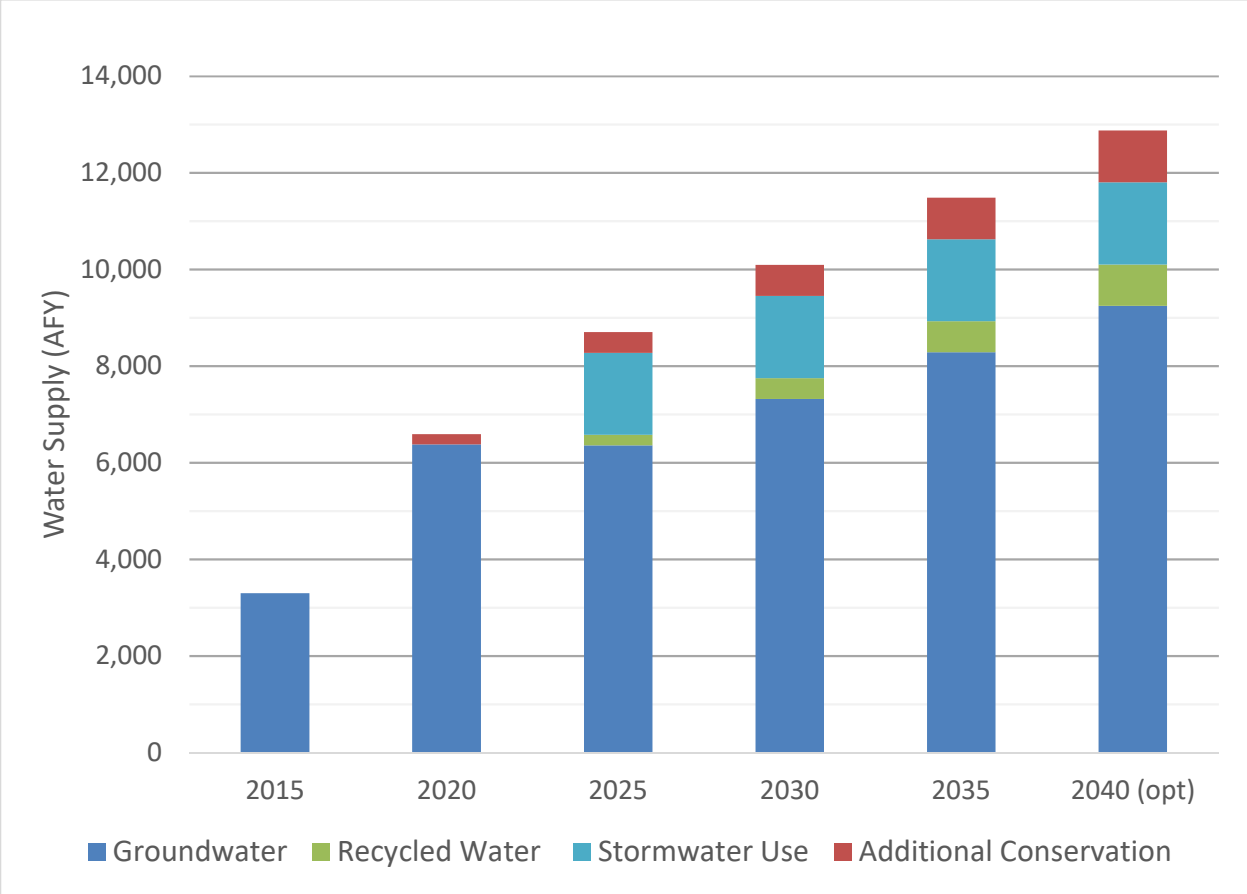
The CIP represents a detailed implementation schedule at the project level, and was presented in Chapter 8. As shown in the detailed CIP, some of the supply sources defined as part of the preferred portfolio for the City will not be implemented immediately. Key to the implementation plan is, of course, the timing of the projects as they relate to the needs that will trigger those projects.

The water supply portfolio, after full implementation, will provide the supply required under future conditions. The demand evolution from current conditions to build-out conditions, however, allows for phasing in the development of the supply options, and phases within a supply option category (e.g., phasing the construction of new wells for ultimate groundwater development).

Figure 9-1 shows the gradual introduction of different supply sources in the City's supply portfolio. This introduction of sources over time has been developed under the following criteria:

- Readiness to implement in the short-term
- Certainty about the yield expected by sources
- Required steps in project development
- Investment require for project implementation

Figure 9-1: Implementation of Future Supply Sources



Readiness to implement in the short-term is critical in deciding the sources to develop by 2020 and is a consideration that is typically more relevant for cities like Patterson, where the current portfolio includes essentially only one source. The "know how" in terms of the new source and operation , and the combined operation of new and existing sources, is an important factor in phasing the entry of a new supply. That "know how" element is also important in terms of the implementation of the project that will bring a new supply, from how to procure that project, manage the design, construction and startup phases, and manage the risk associated with those project elements. With this in mind, the sources targeted for the year 2020 include additional groundwater (within the operational yield presented in Section 4.1) and additional conservation programs.

Certainty about the yield expected by sources is another consideration in the timing and path to implement a project. Some sources, particularly those relying on hydrology-dependent and hydrogeology-dependent supplies, require field and pilot testing to narrow the uncertainty envelop into a firm yield. When demands are expected to grow and the level to which they are growing is reasonably well understood (short-term demand increases by known development projects), the sources to meet the new demands must have the same level of certainty. With this consideration in mind, the stormwater beneficial use project, which involves capturing (diverting) natural flows from a creek into constructed recharge basins, and constructing wells to extract the recharged water, is programmed to be on line in 2025. This allows for the additional field work and pilot tests (recharge tests) that will be required to assess the feasibility and yield associated with the option.

Required steps in project development is a consideration required to define the timing of projects to come online. These steps include pilot tests, conceptual design, design, permitting, environmental documentation, construction and startup. While some of these steps can be implemented with overlap in execution, there is significant time required before a new supply that requires new facilities can be brought online (especially if it is a source that is not currently in the City's portfolio). With this in mind, the supply option corresponding to recycled water from the wastewater facility is programmed for introduction (first phase) in 2025. This source has a very well defined yield (there is no uncertainty associated with this supply, as in the case of stormwater development), but the significant time required for the project (from conceptual design to implementation) makes it a source to implement no sooner than 5 years.

Investment required for project implementation is an important additional consideration in phasing projects and programming their implementation in long-range plans. This is an additional consideration in the timing for recycled water development. While non-potable demands exist today, they can be served with other available non-potable sources (shallow wells) which require much lower investments than the full-scale recycled water project. The considerations about specific timing of capital costs has been discussed and significantly considered in the definition of the CIP described in Chapter 8.

Related to the investment (capital costs) for project implementation, an important factor in implementation is the availability of source of funding, particularly grant funding. The opportunities available that are relevant to Patterson are listed in the following section.

9.2 Funding Opportunities

Multiple loan and grant programs are available for project implementation in California, that are relevant to the projects required by the City and included in the City's CIP. Table 9-1 presents a list of those programs and includes the current status of the program, expected program milestones, and the projects that are eligible under each of them. The City has been proactive and successful in obtaining external funding for multiple projects and will continue to monitor and apply to these programs that leverage the local resources for the benefit of rate payers.

Table 9-1: Grant Program Overview (*January 10, 2017*)

	Grant Program	Administering Agency	Current Status	Future Timeline	Funding Available Total	Funding Available per Round	Eligible Projects
	California - Proposition 1 Funding						
1	Integrated Regional Water Management	Department of Water Resources	No current open solicitation	Implementation Round 1 PSP expected Spring/Summer 2018 (final PSP in June/July 2018)	$22.5M total for Coachella Valley Region (19.8M remaining)	Varies	Multi-benefit implementation projects that meet objectives of Coachella Valley IRWM Plan
2	Water Use and Efficiency Grants: CalConserve Revolving Fund	Department of Water Resources	Applications accepted on first come first serve basis	None; applications accepted on rolling basis until funds exhausted	$6.75M	$6.75M	$1.75M in loans for water efficiency upgrades. $5M for fixing expensive and difficult to repair customer leaks.
3	Stormwater Grant Program	State Water Resources Control Board	No current open solicitation	Implementation Round 2 tentative for 2018	$200M	$80M	Multi-benefit implementation projects that are included in a Storm Water Resources Plan, respond to climate change, contribute to regional water security, and result in a minimum of 2 quantifiable benefits.
4	Water Storage Investment Program	Water Commission and Department of Water Resources	Applications due by August 14, 2017	Unknown	$2.7B	TBD	Water storage projects that produce real and measurable public benefits, and help address the long-term water needs for California families, farms, communities, and the environment. Must provide measurable benefits to the Delta ecosystem or its tributaries.
5	Water Desalination Grant Program	Department of Water Resources	Final PSP released June 16, 2017	Proposals due September 1, 2017	$100M	$93.1M	Projects that create new or alternative potable water supplies using saline water sources (brackish and seawater)
6	Groundwater Sustainability Program	State Water Resources Control Board	Round 2 pre-application solicitation open. Round 1 awarded 8 projects for a total of $22.8M.	Round 2 is underway on a rolling basis. No deadline or closing date.	$800M	Up to $800M	Projects that address groundwater cleanup or prevent contamination of groundwater that serves as a source of drinking water.
7	Sustainable Groundwater Planning Program	Department of Water Resources	Final PSP released. Applications due November 10, 2017.	Unknown	$100M	$86.3M	Projects that develop and implement sustainable groundwater planning and projects.
	Federal - USBR Funding						
8	Title XVI Feasibility Studies	US Bureau of Reclamation	No current open solicitation	TBD; FOAs typically released in October/November each year	TBD	$1M	Water reclamation and reuse feasibility studies for projects that have been previously authorized for Title XVI.
9	Title XVI Construction Grants	US Bureau of Reclamation	No current open solicitation	TBD; FOAs typically released in October/November each year	TBD	$20M	Construction projects that have been previously authorized for Title XVI.
10	Water Infrastructure Improvements for the Nation (WIIN) - Subset of Title XVI	US Bureau of Reclamation	FOA was released on July 17, 2017. Applications are due on August 17, 2017. Awards to be announced early October.	Next solicitation anticipated in fall 2017.	$50M total	$10M	Construction of water recycling treatment and conveyance facilities for projects that have a Title XVI Feasibility Study completed, but are not congressionally authorized. Assumed that funding terms are similar to Title XVI: Maximum grant award of 25% of the total project costs or $20 million, whichever is less.

	Grant Program	Administering Agency	Current Status	Future Timeline	Funding Available Total	Funding Available per Round	Eligible Projects
11	WaterSMART: Drought Response Program	US Bureau of Reclamation	No current open solicitation	Unknown, though program has had annual funding opportunities since 2015	$4M total	TBD	Planning funding - up to $200k to develop a new drought plan or update existing plan. Project funding - $300k-$750k for projects that increase water reliability, improve water management, implement systems to facilitate voluntary sale, transfer, or exchange of water, and provide benefits to the environment. 50% non-federal cost share required.
12	WaterSMART: Water Marketing	US Bureau of Reclamation	FOA closed on April 19, 2017. Nine projects were awarded $2.1M.	Next solicitation currently unscheduled.	$3M total	TBD	For planning activities to develop a water marketing strategy to establish or expand water markets or water marketing transactions. For planning only - $200k-$400k available for projects that address: outreach and partnership building, scoping and planning, development of a water marketing framework.
13	WaterSMART: Water and Energy Efficiency	US Bureau of Reclamation	No current open solicitation	Next solicitation currently unscheduled	TBD	TBD	$300k-$1M for projects that result in quantifiable and sustained water savings and that may have several components intended to address a significant water management concern (canal lining and piping, installation of water meters, etc.).
14	WaterSMART: Small-Scale Water Efficiency	US Bureau of Reclamation	FOA closed on May 15, 2017. 57 projects were funded a total of $3.6M.	Next solicitation currently unscheduled	Up to $2M	TBD	Up to $75k for new small-scale water efficiency projects that have been identified through previous planning efforts. Eligible projects include installation of flow measurement or automation in a specific part of a water delivery system, lining of a section of a canal to address seepage, small rebate programs that result in reduced residential water use, or other similar projects that are limited in scope.
16	Water Infrastructure Finance and Innovation Act (WIFIA)	US EPA	Selection period from August 1, 2017 - September 29, 2017	Unknown	$1.5B	$45M	Funding for construction of wastewater conveyance and treatment projects, drinking water treatment and distribution projects, desalination, and water recycling projects. Minimum project size for large communities (pop. >25,000) is $25M; for small communities, projects must be at least $5M. Maximum of 49% of the project cost can be financed through the program. Loans are for 25 years or useful life of the project, whichever is less. Non-refundable application fees between $400,000 - $700,000 per applicant.

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Appendix A - Chromium VI Feasibility Study

City of PATTERSON California

Hexavalent Chromium Feasibility Study Draft Report

Prepared by:

RMC water and environment

January 2017

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Appendices

Appendix A - Water Quality and Cost Analysis Material

Chapter 1 Introduction

The City of Patterson (City) is currently out of compliance with the maximum contaminant limit (MCL) for hexavalent chromium (Chrome 6) in its potable water supply. As a response measure in its planned efforts to achieve compliance, the City authorized a Hexavalent Chromium Feasibility Study (Feasibility Study) to evaluate Chrome 6 treatment alternatives and treatment system siting options. This Feasibility Study contains the findings and recommendations from this evaluation.

1.1 Chrome 6 Regulatory Setting

The State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW) is the regulatory agency responsible for drinking water in the State of California. Their purview includes the development and enforcement of drinking water regulations as stipulated in the California Code of Regulations (CCR), Title 22, Division 4. Also included are water quality requirements as listed in Chapter 15 under Division 4 in the form of MCLs for regulated constituents. Constituents that are regulated with MCLs have been identified to either a.) have known human health effects; or b.) create aesthetic issues in drinking water (e.g., odor, color, taste, etc.).

Chrome 6 is a constituent known to be a carcinogen when inhaled, with additional research showing that it is a potential carcinogen when ingested[1]. These findings moved DDW to further study the health risks and ultimately develop a drinking water MCL for this constituent. A Chrome 6 MCL of 0.010 mg/L was formally adopted on July 1, 2014.

1.1.1 Best Available Technologies for Treatment

For the treatment of Chrome 6, there are specific technologies that have been designated by DDW as Best Available Technologies (BATs) for treatment. These are identified in CCR Title 22, Division 4, Chapter 15, Article 12 § 64447.2 and consist of the following:

- Coagulation-Filtration for systems with 500 or more service connections. Specifically, the Chrome 6 treatment process using this BAT is Reduction-Coagulation-Filtration (RCF) with ferrous sulfate as the reducing agent.
- Ion Exchange. For Chrome 6 treatment, the ion exchange processes considered BAT are Weak Base Anion exchange (WBA) and Strong Base Anion exchange (SBA).
- Reverse Osmosis (RO).

These technologies have been designated as BAT due to their extensive prior field/pilot scale testing and/or full scale demonstration for Chrome 6 treatment. As a result, use of a BAT treatment process for a new full-scale treatment system will have the fewest pilot testing requirements and have a high likelihood of receiving permit acceptance by DDW. Conversely, to consider the use of non-BAT treatment technologies would require significant pilot and/or full-scale demonstration testing beyond what would be needed for a BAT process, and at significantly greater time and cost. Furthermore, the findings from such testing would not assure permit acceptance of a full-scale treatment system by DDW. For these reasons, only BAT processes for Chrome 6 treatment were considered for evaluation in this Feasibility Study.

1.1.2 Sources for Chrome 6 in Groundwater Supplies

Chrome 6 can find its way into potable groundwater supplies through one of two general pathways:

[1] 2015, DDW Hexavalent Chromium Fact Sheet

1. Contact of the groundwater with geologic formations that contain naturally occurring chromium deposits. As the groundwater is extracted by potable wells, a portion of the Chrome 6 in the geology dissolves and becomes present in the water.
2. Percolation of surface discharges containing Chrome 6 that make its way to the water table and into the groundwater basin. Surface discharges of this type would generally come from industrial wastewater sources.

It is our understanding that there has been historically little or no industrial Chrome 6 use within the City's service area, and no industrial use at present. This indicates that the Chrome 6 in the City's potable supply likely originated from the geology from which the groundwater is extracted. This is further supported by well sampling data compiled by DDW for Chrome 6, which shows potable wells in the neighboring cities of Ceres and Newman to also have concentrations above the MCL.

1.2 Project Background

The City of Patterson is the retail purveyor for potable water within the City's service area. They do not have access to surface water or imported water supplies, so drinking water demands are met entirely through local groundwater extracted from seven City owned and operated potable wells. Historically, the City has met all water quality requirements for its potable water as stipulated in the drinking water regulations.

Following the July 1, 2014 adoption of the Chrome 6 MCL by DDW, the City initiated quarterly monitoring for Chrome 6 in their potable wells as required by regulation, along with supplemental sampling for their non-potable wells. The results revealed that the Chrome 6 MCL was consistently exceeded in all of the potable as well as non-potable wells. DDW reviewed the potable well monitoring results and subsequently issued Compliance Order (CO) No. 01_10_15R_001, requiring the City to take action to achieve compliance. The CO was issued to the City on July 29, 2015.

As the initial response action to the CO, DDW required the City submit a Corrective Action Plan (CAP) outlining the steps and estimated timeframe needed to achieve Chrome 6 compliance. Given the City's lack of access to alternate water supplies for blending or replacement of their existing groundwater wells, the CAP was developed with the focus on Chrome 6 source mitigation (if possible) and/or treatment of the water after extraction from the ground. Using this source mitigation/treatment approach, the City submitted a CAP to DDW with a structure consisting of the following steps:

1. Field Testing of Wells to determine the potential for Chrome 6 source control.
2. Feasibility Study to evaluate and screen treatment and facility siting alternatives.
3. Pilot Testing to develop/confirm site specific design criteria for the selected Chrome 6 treatment process.
4. Basis of Design Report to establish the final criteria for a Chrome 6 treatment process to be used as the design basis for the full scale treatment facility.
5. Engineering Design of the Chrome 6 treatment facility.
6. Environmental Documentation to address the environmental and approval/permitting requirements stipulated by the California Environmental Quality Act (CEQA).
7. Permitting to allow construction and commissioning of the Chrome 6 treatment facility and related potable system infrastructure improvements needed to support the facility.
8. Funding/Financing to obtain grants and/or loans available from the State of California to offset a portion of the costs for the Chrome 6 treatment facility.

9. Construction of the Chrome 6 treatment facility and associated potable system infrastructure improvements.
10. Commissioning of the Chrome 6 treatment facility and formal acceptance by DDW in achieving compliance.

The City's CAP received DDW approval on October 14, 2015. Step 1 of the CAP was begun in early 2016 and is still in progress at this writing. This report presents the evaluation findings for Step 2 of the CAP, the Feasibility Study.

1.3 Objectives of Study

This Feasibility Study was conducted to meeting the following two objectives:

1. To evaluate the potential treatment and siting alternatives available to the City to achieve Chrome 6 compliance in its potable water supply and to recommend the alternative(s) best suited to address the site-specific conditions in Patterson. The treatment and siting options evaluated consist of combinations of the following:
    a. The technologies noted in Chapter 1.1.1. as BAT for Chrome 6 treatment by DDW.
    b. Siting at each wellhead with individual treatment systems or siting at a single centralized treatment facility.

    Each treatment system configuration and siting alternative combination was considered for technical and logistical feasibility. Lifecycle costs were developed for each afterwards. These costs were then unitized on a dollar per acre-foot basis to allow the comparison of the wellhead treatment options to the centralized treatment facility options.
2. To evaluate whether total dissolved solids (TDS) and/or nitrate treatment in the City's potable water supply may require treatment in the future. Both are currently below their respective MCLs (i.e., <45 mg/L for nitrate and <1,000 mg/L for TDS). However, the City's Water Supply Master Plan has indicated that the concentrations of both could increase where treatment might eventually be needed. To address this issue, the following was performed in this The Feasibility Study:
    a. Conducted a trend analysis for each well using the available historical water quality to determine if either constituent would be projected to increase in the future above their respective MCLs.
    b. Assessed the feasibility of treatment for these constituents using the BAT processes for Chrome 6 treatment. The intent was to identify if the technologies could provide a cost effective means of addressing these constituents while achieving Chrome 6 compliance.

    Note that the scope of this effort excluded the evaluation of separate treatment systems to address TDS and/or nitrate outside of the Chrome 6 BAT processes.

1.4 Basis for Analysis and Evaluation Approach

To screen through the possible combinations of treatment process and siting options to arrive at a recommended alternative, the following approach was used:

1. Historical water quality data and the production capacity for each well was provided by the City. These data were compiled and analyzed to establish a baseline by well for the City's potable water supply. (Chapter 2).
2. Based on the historical water quality data, further analysis for nitrate and TDS were performed to estimate the potential concentrations for these constituents at the time horizon for City build out

(i.e., 2050). The results would provide a basis for assessing the need for treatment of these constituents. (Chapter 2).

3. A treated water quality goal was established for Chrome 6, based on the MCL and discussions with the City. Additionally, initial and ultimate conceptual treatment plant capacities were established based on projected potable demands for the years 2030 and 2050. These years were established based on discussions with the City, with the projected demands taken from the City's Water Supply Master Plan. (Chapter 2).
4. A detailed description of each treatment process was developed, with a discussion of the reaction chemistry, unit operations required for each process, ancillary and support system needs, residuals generated, and disposal options for residuals. Additionally, treatment process specific issues were presented (e.g. solids dewatering, waste characterization for the purposes of determining allowable disposal). (Chapter 3).
5. Footprint requirements for each treatment process were estimated for individual wellhead treatment scenarios. In this analysis, GIS data provided by the City was used to estimate the space available at each wellhead site. The footprint requirements for each treatment process was compared against the space available to determine logistical feasibility. (Chapter 4).
6. Conceptual treatment system configurations were developed for a centralized facility. The location for the centralized system was provided by the City. Initial and ultimate treatment plant capacities were based on the potable demand projections in the years 2030 and 2050, as noted in (3). An additional conceptual level analysis was performed for the necessary conveyance pipelines for a centralized system. These include the raw water pipelines, treated water pipeline, and residual disposal pipeline (i.e., sewer connection). (Chapter 5).
7. Conceptual level lifecycle costs were developed for the treatment process/siting option combinations. These costs included planning level capital costs and operations and maintenance (O&M) costs for each alternative developed through the year 2050 (Chapter 6).
8. Based on the siting feasibility of each alternative, conceptual lifecycle cost, and consideration for residual generation/handling/disposal, recommendations for a future treatment system were presented (Chapter 7).

Chapter 2 Design Flows and Water Quality

This chapter presents the design flow rate criteria, treated water goals, and design raw water quality that were used as the basis for developing the conceptual configuration for each treatment technology alternative. Additionally, the analysis of nitrate and TDS to determine the potential future need for treatment is presented in this chapter.

2.1 Design Flow Rates

The design flow rates used for purposes of individual well head treatment and for the centralized treatment facility alternatives were established based on the existing well capacity data as well as discussions with the City. The well locations and parcel for a potential centralized treatment facility are shown in Figure 2-1.

Figure 2-1: Potable Well and Potential Centralized Facility Locations

The production capacities for the wells are presented in Table 2-1.

Table 2-1: Production Capacities for Potable Wells

Well	Flow (gpm)
2	800
5	1,400
6	600
7	1,500
8	1,000
9	800
11	1,200
Total Current Wells	*7,300*
14 (future)[a]	1,200

Footnotes:
a. Future Well No. 14 to replace Well No. 2 for centralized facility alternatives.

For evaluation of the treatment alternatives at the wellhead sites, one treatment system would be sited at each current well location (i.e., Wells No. 2 – 11). The conceptual treatment system capacity and associated equipment space requirements for each well location was based on the production capacity its respective well. For evaluation of treatment alternatives at a centralized facility, Well No. 2 would be replaced with the future Well No. 14. In this scenario, Well No. 2 would be converted to non-potable use. This change was made to avoid the potential logistical complications associated with routing a conveyance pipeline from the Well No. 2 location through the City to centralized facility. Replacement of Well No. 2 with Well No. 14 would facilitate this routing, as it is located in the northern portion of the City's service area outside of residential developments. Per discussions with the City, Well No. 14 is anticipated to have a production capacity of 1,200 gpm.

For sizing of treatment system alternatives at a centralized facility, the potable demands projected for the years 2030 and 2050 were used for the initial and ultimate treatment capacity requirements. Selection of these years was based on discussions with City staff. Using the future potable demand projections from the City's Water Supply Master Plan, the following were established as the capacity requirements for a centralized system:

- Initial centralized facility capacity: 8,550 gpm. This is based on the peak day demand for the year 2030.
- Ultimate centralized facility capacity: 13,400 gpm. This is based on the peak day demand for the year 2050.

The use of peak day demand for system sizing is based on the premise that there is sufficient storage available within the existing potable distribution system to accommodate the diurnal peak hour demands during the peak day of the year. Use of a different peaking factor (e.g., peak week, peak month) would reduce the size of the treatment system. However, it would require confirmation that there is already sufficient existing storage in the potable distribution system or that such storage would be available prior

to the implementation of the Chrome 6 treatment system. For the purposes of this Feasibility Study, it is assumed that such distribution system storage is not and will not be available.

2.2 Treated Water Goals

As noted in Chapter 1, the recommended treatment process and siting for the system will need to achieve a Chrome 6 concentration below the MCL of 0.010 mg/L. Additionally, the evaluation of the Chrome 6 treatment processes will consider the feasibility of treating TDS and/or nitrate if treatment for either is deemed necessary in the future. Based on the existing DDW regulations and discussions with the City, the following were established as treated water quality goals:

- Chrome 6: ≤0.005 mg/L.
- TDS: ≤1,000 mg/L or ≤500 mg/L, if possible. DDW regulation specifies TDS as a secondary MCL, with an upper limit of 1,000 mg/L and a recommended target of 500 mg/L (CCR Title 22, Division 4, Chapter 15, Article 16 § 64449). This goal will only be evaluated if TDS treatment is projected to be needed in the future. If so, the BAT processes evaluated for Chrome 6 treatment will be assessed for their potential for TDS reduction and whether 1,000 mg/L secondary MCL and/or the 500 mg/L recommended target are achievable.
- Nitrate: ≤45 mg/L. This goal will only be evaluated if nitrate treatment is projected to be needed in the future. If so, the BAT processes evaluated for Chrome 6 treatment will be assessed for their potential to reduce nitrate to below the MCL of 45 mg/L.

2.3 Source Water Quality

2.3.1 Individual Wells

Well Nos. 2, 5, 6, 7, 8, 9, and 11 provide the entirety of the potable water supply for the City. Their locations were shown earlier in Figure 2-1. Water quality for these wells were provided from the City and were comprised of the following sources:

- Historical City water quality database covering the timeframe from September, 1984 through June, 2016.
- City Consumer Confidence Reports from 2011 through 2015.
- Quarterly well monitoring data for Chrome 6 from the 4th quarter of 2014 through the 1st quarter of 2016.

The data from these sources were compiled to generate averages and reported concentration ranges for the water quality parameters reported. These are presented in Table 2-2.

Table 2-2: Historical Water Quality for Potable Wells

Well	Alkalinity (mg/L)	Ba (µg/L)	Ca (mg/L)	Cl (mg/L)	Cu (µg/L)	F (mg/L)	Gross Alpha (pCi/L)	U[a] (µg/L)	Fe (µg/L)	Pb (µg/L)	Mg (mg/L)	Mn (µg/L)	NO_3 (mg/L)	K (mg/L)	Na (mg/L)	SO_4 (mg/L)	TDS (mg/L)	Turbidity (NTU)	Cr 6 (µg/L)
Well No. 2																			
Min.	150	0	67	112	0	0.21	-----	-----	0	0	58	0	21	1	126	-----	860	0	15.0
Average	174	38	76	142	9.4	0.33	-----	-----	103	0.8	62	8.3	31.0	2.2	142	-----	950	0.6	16.9
Max	200	200	86	170	25	0.40	-----	-----	429	5	69	15	39.5	3	160	-----	1000	2.8	19.0
Well No. 5																			
Min.	-----	0	61	-----	0	0	-----	-----	0	0	32.7	0	1	3	90	191	720	-----	15.7
Average	-----	87	74	-----	29.5	0.15	-----	-----	70	1.8	54	8.6	5.5	3.5	107	219	825	-----	16.4
Max	-----	500	89.2	-----	110	1.00	-----	-----	140	10	60	15	11.1	4	121	260	900	-----	17.0
Well No. 6																			
Min.	170	0	68	-----	0	0.2	-----	-----	0	0	52	0	16	2	124	351	900	0.2	18.0
Average	183	15	77	-----	7.5	0.30	-----	-----	64	0.4	58	20.0	27.5	2.2	149	380	957	2.7	19.2
Max	200	20.3	87	-----	10	0.40	-----	-----	200	1.6	65	70	37.5	3	161	420	1030	16.9	21.0
Well No. 7																			
Min.	91	22	60	-----	10	0.1	-----	-----	40	0.2	47	10	3.8	3	99	224	680	0.2	25.0
Average	124	30	77	-----	18.3	0.10	-----	-----	101	0.9	58	10.0	8.2	3.2	122	290	854	1.0	33.3
Max	140	35.2	107	-----	50	0.10	-----	-----	250	4	79	10	17.2	4	162	380	1260	2.9	38.1
Well No. 8																			
Min.	-----	25	43	-----	5	0.1	-----	-----	50	0.2	32	10	2.8	2	66	180	480	0.2	14.4
Average	-----	28	54	-----	9.0	0.18	-----	-----	97	2.0	40	10.0	7.5	2.6	88	270	619	1.1	17.8
Max	-----	36.2	84	-----	10	0.30	-----	-----	190	7	63	10	15.9	3	137	500	1030	2.2	19.0
Well No. 9																			
Min.	-----	24.8	47	-----	10	0.1	0.87	1.30	100	0.2	36	10	5.7	3	74	221	490	0.2	7.0
Average	-----	26	49	-----	10.0	0.10	3.55	5.32	100	0.4	37	10.0	7.2	3.0	76	229	537	0.4	16.7
Max	-----	26.5	50	-----	10	0.10	5.28	7.92	100	0.5	37	10	10.7	3	78	237	570	0.6	26.0
Well No. 11																			
Min.	140	25.2	44	-----	10	0.1	-----	-----	50	0.2	31	10	0.4	2	59	-----	460	0.2	14.0
Average	148	28	51	-----	10.0	0.10	-----	-----	168	2.9	35	12.5	3.5	2.8	64	-----	503	6.2	15.4
Max	150	31	55	-----	10	0.10	-----	-----	300	10.8	38	20	7.4	3	67	-----	520	14.4	17.0
Well No. 14 (Future)[b]																			
Min.	128	14.8	55	112	5.5	0.10	0.87	1.30	34	0.1	40.0	6.2	5.7	2.4	88	221	641	0.2	18.1
Average	149	39.6	66	142	15.1	0.16	3.55	5.32	103	1.4	49.0	10.8	10.8	2.9	104	269	742	2.1	19.9
Max	163	139.7	82	170	39.0	0.36	5.28	7.92	228	6.2	59.6	18.1	17.6	3.4	126	354	915	6.2	21.3

Footnotes:

a. Uranium concentration estimated based on conversion factor of 1.5 for gross alpha radiation (i.e. U (µg/L) = 1.5 x gross alpha (pCi/L)).
b. Well No. 14 parameters estimated based on flow weighted values from all current potable wells.

As noted in Chapter 2.1, Well No. 2 will be replaced with a future Well No. 14, with Well No. 2 to be converted to non-potable use. The values for the water quality parameters shown for Well No. 14 are based on the flow weighted averages of all of the current potable wells (i.e., Well Nos. 2, 5, 6, 7, 8, 9, and 11). The maximum value for each constituent was used in the analysis for treatment equipment sizing.

2.3.2 Aggregate for Potable System

For a centralized treatment system, an aggregate of the water quality data for the 7 active potable wells was developed for use in sizing of the treatment equipment needed and the space requirements for each treatment technology alternative. The values for the water quality parameters were estimated based on the flow weighted contributions from the current potable wells. These values are presented in Table 2-2.

Table 2-3: Estimated Water Quality for Potable System

Parameter	Unit	Value			Source
		Min.	Average	Max.	
Alkalinity	mg/L	128	149	163	Historical data 09/1984 - 6/2016
Ba	µg/L	15	40	140	Historical data 09/1984 - 6/2016
Ca	mg/L	55	66	82	Historical data 09/1984 - 6/2016
Cl	mg/L	112	142	170	Historical data 09/1984 - 6/2016
Cu	µg/L	5.5	15	39	Historical data 09/1984 - 6/2016
F	mg/L	0.10	0.16	0.36	Historical data 09/1984 - 6/2016
Gross Alpha	pCi/L	0.9	3.5	5.3	Historical data 09/1984 - 6/2016
U (estimated)	µg/L	1.3	5.3	7.9	Historical data 09/1984 - 6/2016
Fe	µg/L	34	103	228	Historical data 09/1984 - 6/2016
Pb	µg/L	0.1	1.4	6.2	Historical data 09/1984 - 6/2016
Mg	mg/L	40	49	60	Historical data 09/1984 - 6/2016
Mn	µg/L	6.2	11	18	Historical data 09/1984 - 6/2016
NO_3	mg/L	5.7	11	18	Historical data 09/1984 - 6/2016
K	mg/L	2.4	2.9	3.4	Historical data 09/1984 - 6/2016
Na	mg/L	88	104	126	Historical data 09/1984 - 6/2016
SO_4	mg/L	221	269	354	Historical data 09/1984 - 6/2016
TDS	mg/L	641	742	915	Historical data 09/1984 - 6/2016
Turbidity	NTU	0.2	2.1	6.2	Historical data 09/1984 - 6/2016
Hexavalent Chromium	**µg/L**	**18.1**	**19.9**	**21.3**	Data Q4 2014 - Q1 2016
Total Chromium	µg/L	16.0	18.8	25.0	2011 - 2015 Consumer Confidence Reports
pH	unit	-----	8.0	-----	05/25/2001 WQ Report for Well No. 10

Note that the values for total chromium and pH were extracted from separate sources and were not flow weighted given nature of the sources. The maximum value for each constituent per Table 2-3 was used in the analysis for treatment equipment sizing.

2.4 Potential Future Water Quality Concerns

The City Water Supply Master Plan identified TDS and nitrate as two constituents that could exceed their respective MCLs in the future and require treatment. To determine the potential need for treatment, a statistically based trend analysis was performed for each constituent using the data from September, 1984

through June, 2016 in the water quality dataset provided by the City. The following methodology was used to conduct this analysis:

1. The historical data for TDS was compiled for each well.
2. A logarithmic regression analysis was applied to the data to yield a best fit curve equation.
3. For each point in the historical dataset, the difference was calculated between the actual data point and its respective projected value generated from the best fit curve equation. These differences were compiled into a standard error dataset for each well.
4. A standard deviation was calculated for the standard error dataset of each well.
5. Projected TDS concentrations for the years 2030 and 2050 were extrapolated for each well based on their respective best fit curve equations.
6. Two standard deviations were added to the projected TDS concentrations for each well at 2030 and 2050 to yield adjusted concentrations at the 97.5 percentile (i.e., the projected concentration is estimated to have a 97.5% probability of being at this value or lower).
7. The adjusted TDS concentrations for the wells at 2030 were flow weighted and combined to yield an aggregate concentration for the overall potable system.
8. The adjusted TDS concentrations for the wells at 2050 were flow weighted and combined to yield an aggregate concentration for the overall potable system.
9. Steps (1) through (8) above were repeated using the historical nitrate data.

The findings of the trending analyses are presented below.

2.4.1 Total Dissolved Solids (TDS)

The findings from the TDS trend analysis are presented in Table 2-4. Charts with plots of the historical data and logarithmic regression trend lines are included in Appendix A.

Table 2-4: TDS Trend Analysis Summary

Potable Source	TDS Concentration (mg/L)			TDS Standard Deviation (mg/L)	TDS Concentration +2 Standard Deviations (mg/L)	
	Current[a]	2030	2050		2030	2050
Well No. 2	930	949	949	25	999	999
Well No. 5	870	886	925	23	933	972
Well No. 6	930	964	968	19	1,001	1,006
Well No. 7	1,260	1,449	1,838	53	1,554	1,943
Well No. 8	1,030	1,346	1,885	61	1,468	2,007
Well No. 9	550	700	857	13	725	883
Well No. 11	520	484	468	13	511	494
Aggregate Current System[b]	891	992	1,168	32	1,055	1,231
Well No. 14 (future)[c]	891	992	1,168	32	1,055	1,231
Aggregate Future System[d]	----	1,055	1,231	32	1,119	1,295

Footnotes:

a. Average of data for from 2014 through 2016 for individual wells. An average for this timeframe was used due to the limited recent data available for each well.
b. Aggregate system is based on flow weighted concentrations for Well Nos. 2, 5, 6, 7, 8, 9, and 11.
c. Well No. 14 will replace Well No. 2 in the future. Concentrations are assumed equal to the system aggregate for purposes of analysis since Well No. 14 has not been constructed.
d. Aggregate system concentration for Well Nos. 5, 6, 7, 8, 9, 11, and 14.

The trend analysis for TDS indicates the following:

- For the 1,000 mg/L secondary MCL –
    - Well Nos. 7 and 8 already exceed this limit (1,260 mg/L and 1,030 mg/L, respectively).
    - The 97.5 percentile projected concentrations for Well Nos. 2 and 6 will be at or just above this limit by 2030 (999 mg/L and 1,001 mg/L, respectively).
    - The 97.5 percentile concentration for the aggregate system is projected to exceed this limit by 2030.
    - The 97.5 percentile concentrations for Well Nos. 5, 9, and 11 are projected to be below this limit through 2050.
- All wells are currently above the 500 mg/L DDW recommended TDS target

The following conclusions were drawn from these findings:

- To meet the 1,000 mg/L secondary MCL for TDS at 2050, treatment would be needed on Wells No. 7 and 8, as these wells are already above 1,000 mg/L in TDS and are projected to continue increasing in the future. Since the other wells are projected to remain below 1,000 mg/L through 2050, treatment of Wells No. 7 and 8 should allow the City to meet the 1,000 mg/L MCL.
- To meet the 500 mg/L DDW recommended TDS target, treatment of flow from all of the wells except would be required.

- To meet either of the TDS goals, further analysis would be required to determine whether individual wellhead systems or a centralized facility would be the more cost effective option for stand-alone TDS treatment. This would need to be conducted in a separate effort, as this study is limited to evaluating the BAT processes to treat for Chrome 6.

2.4.2 Nitrate

The findings from the nitrate trend analysis are presented in Table 2-5. Charts with plots of the historical data and logarithmic regression trend lines are included in Appendix A.

Table 2-5: Nitrate Trend Analysis Summary

Potable Source	Nitrate Concentration (mg/L)			Nitrate Standard Deviation (mg/L)	Nitrate Concentration +2 Standard Deviations (mg/L)	
	Current[a]	2030	2050		2030	2050
Well No. 2	34.5	39.3	45.8	1.7	42.6	49.2
Well No. 5	6.7	9.2	11.5	0.9	11.0	13.4
Well No. 6	28.6	38.5	46.6	1.6	41.7	49.8
Well No. 7	17.2	17.4	24.2	1.3	20.0	26.8
Well No. 8	9.5	15.6	22.0	2.0	19.7	26.1
Well No. 9	8.4	13.9	20.8	0.8	15.5	22.3
Well No. 11	5.5	9.7	15.2	0.8	11.3	16.9
Aggregate Current System[b]	14.1	18.1	23.8	1.3	20.6	26.3
Well No. 14 (future)[c]	14.1	18.1	23.8	1.3	20.6	26.3
Aggregate Future System[d]	-----	15.9	21.5	1.2	18.3	24.0

Footnotes:

a. Average of data from 2014 through 2015 for individual wells. No data available for 2016.
b. Aggregate system is based on flow weighted concentrations for Well Nos. 2, 5, 6, 7, 8, 9, and 11.
c. Well No. 14 will replace Well No. 2 in the future. Concentrations are assumed equal to the system aggregate for purposes of analysis since Well No. 14 has not been constructed.
d. Aggregate system concentration for Well Nos. 5, 6, 7, 8, 9, 11, and 14.

The trend analysis for nitrate indicates the following:

- The 97.5 percentile concentrations for Well Nos. 2 and 6 are projected to exceed the 45 mg/L MCL by the year 2050 (49.2 mg/L and 49.6 mg/L, respectively).
- The 97.5 percentile concentrations for Well Nos. 5, 7, 8, 9, and 11 are projected to be below the MCL through 2050.
- The 97.5 percentile concentration at 2050 for the aggregate system is projected to be below the MCL.

The following conclusions were drawn from these findings:

- In accordance with the City, Well No. 2 will be replaced in the Well No. 14 and converted to non-potable use. Therefore, further consideration for nitrate treatment of this well will not be needed.

- Wellhead treatment for nitrate at Well No. 6 may be needed in the future if the water produced from this well were to be introduced directly in to the potable distribution system without blending.
- Aggregation of the well flows would allow the overall system to remain below the 45 mg/L MCL through the 2050, as the elevated concentration from Well No. 6 would be blended with the lower concentrations from the other well flows prior to introduction into the potable system. This could be achieved through the implementation of a centralized facility for Chrome 6 treatment.

Chapter 3 Treatment and Siting Alternatives

Presented in this chapter are the descriptions for the reduction-coagulation-filtration (RCF), weak base anion exchange (WBA), strong base anion exchange (SBA), and reverse osmosis (RO) technologies. The descriptions include the treatment principle for each technology; the steps and unit operations involved in each treatment process; the residuals generated by each process; any potential limitations and/or technology specific issues; an assessment of effectiveness for treating nitrate and TDS; and the base design criteria used for conceptual configuration and system sizing. Also included in this chapter are descriptions of the siting options for individual wellhead treatment and for a centralized treatment system.

3.1 Reduction-Coagulation-Filtration (RCF)

RCF is a chemical treatment and physical separation process. It begins with the addition of a reducing agent to the raw water to convert the dissolved Chrome 6 to Chrome 3. As part of this reaction, the Chrome 3 precipitates out of solution as solid particles. The Chrome 3 solids are then coagulated and removed with a filter system to yield the treated water.

3.1.1 RCF Treatment Process Steps and Chemistry

The RCF process consists of three general treatment operations: reduction of the Chrome 6 to Chrome 3, coagulation of the Chrome 3 solids to facilitate removal, and filtration to complete the treatment process by removal of the Chrome 3 solids. This is followed by blending of the treated effluent with water bypassed around the treatment process to yield the product water that meets the treated water goal. The product water is sent to potable distribution. Figure 3-1 shows a general process flow diagram for the treatment process. Each operation is described below.

Reduction

At the influent of the RCF treatment process, ferrous sulfate is added as the reducing agent to the raw water entering the reducing tank. The ferrous iron (Fe^{2+}) of the ferrous sulfate then reacts with the Chrome 6, which is believed to exist predominantly in the form of the chromate ion (CrO_4^{2-}), reducing the chromate to Chrome 3 (Cr^{3+}) while oxidizing the ferrous iron to ferric iron (Fe^{3+}). This is shown in the reaction below.

$$CrO_4^{2-} + 3\ Fe^{2+} + 4\ H_20 \rightarrow Cr^{3+} + 3\ Fe^{3+} + 8\ OH^-$$

This is followed by the reactions below that occur immediately upon the formation of Chrome 3 and ferric iron:

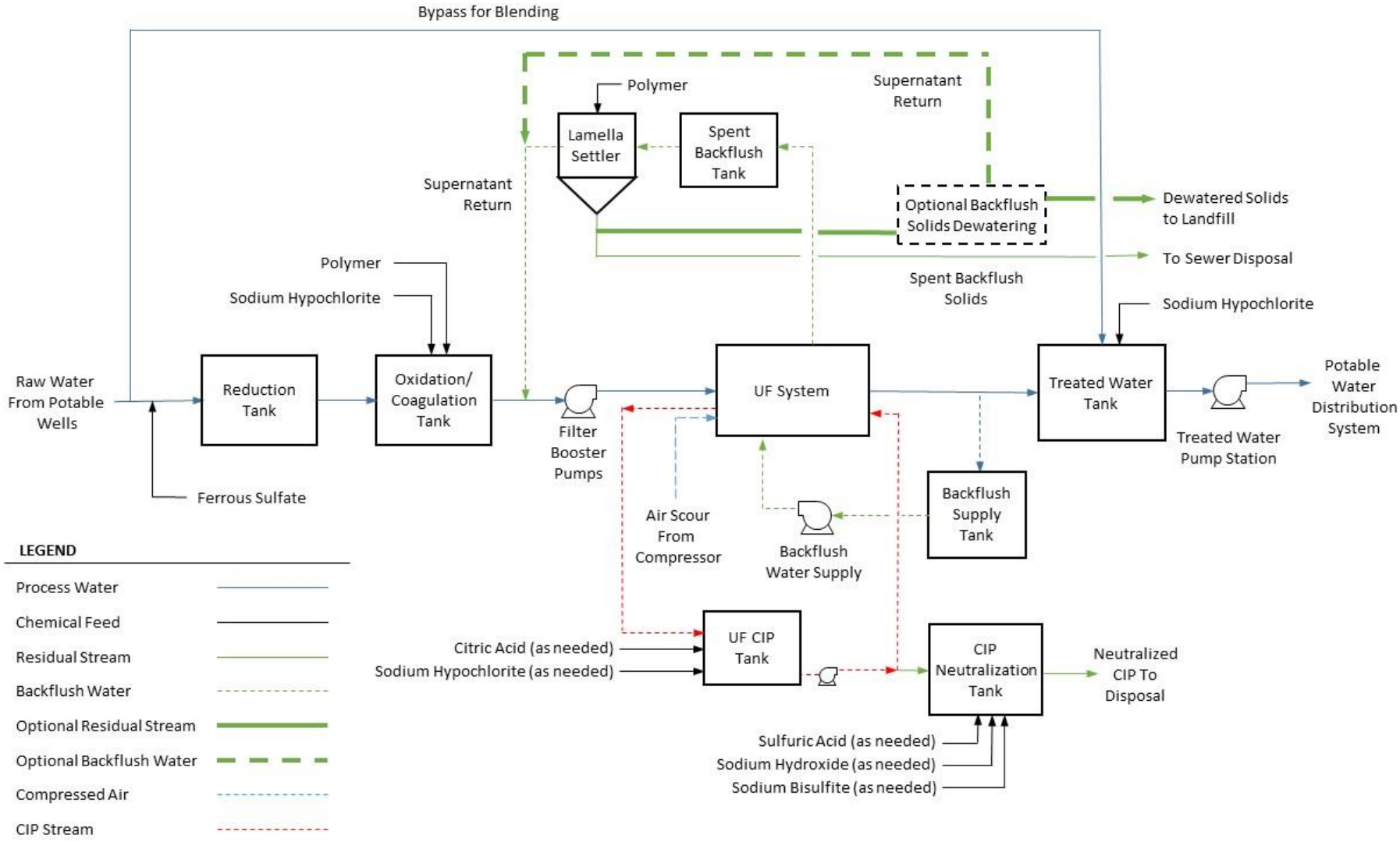
$$Cr^{3+} + 3\ OH^- \rightarrow Cr(OH)_3$$

$$Fe^{3+} + 3\ OH^- \rightarrow Fe(OH)_3$$

The Chrome 3 and ferric iron react with the hydroxide ions (OH-) produced from the chromate reduction reaction to form chromium hydroxide ($Cr(OH)_3$) and ferric hydroxide ($Fe(OH)_3$), both of which precipitate out of the water as solid particulates.

Note that excess ferrous sulfate beyond the stoichiometric minimum required to reduce Chrome 6 to Chrome 3 is typically used to accelerate the reduction reaction. This is done to reduce the contact time required and minimize the size of the tankage needed for the process. In doing so, a portion of the ferrous iron fed to the reduction tank effluent will remain in the ferrous form.

Figure 3-1: RCF Process Flow Diagram



Coagulation

From the reducing tank, the water now containing chromium hydroxide and ferric hydroxide solids is fed into an oxidation/coagulation tank where sodium hypochlorite is initially added to oxidize the residual ferrous iron to ferric iron. This is followed by the addition of a polymer, which is used to aid in the agglomeration of the chromium hydroxide and ferric hydroxide particles into larger particles to facilitate removal by filtration.

Note that the addition of sodium hypochlorite is intended to oxidize the residual ferrous iron to its ferric form so it can precipitate out as a solid particulate. This is necessary to prevent the release of iron into the potable distribution system. If left in its ferrous form, the residual iron would remain dissolved and would not be removed by the filtration step of the RCF process. The treated effluent containing the iron would then to pass into the potable distribution system. At the ferrous sulfate dosing rates required for the RCF process, the iron concentration in the treated effluent could exceed its secondary MCL of 0.3 mg/L if allowed into the potable water system.

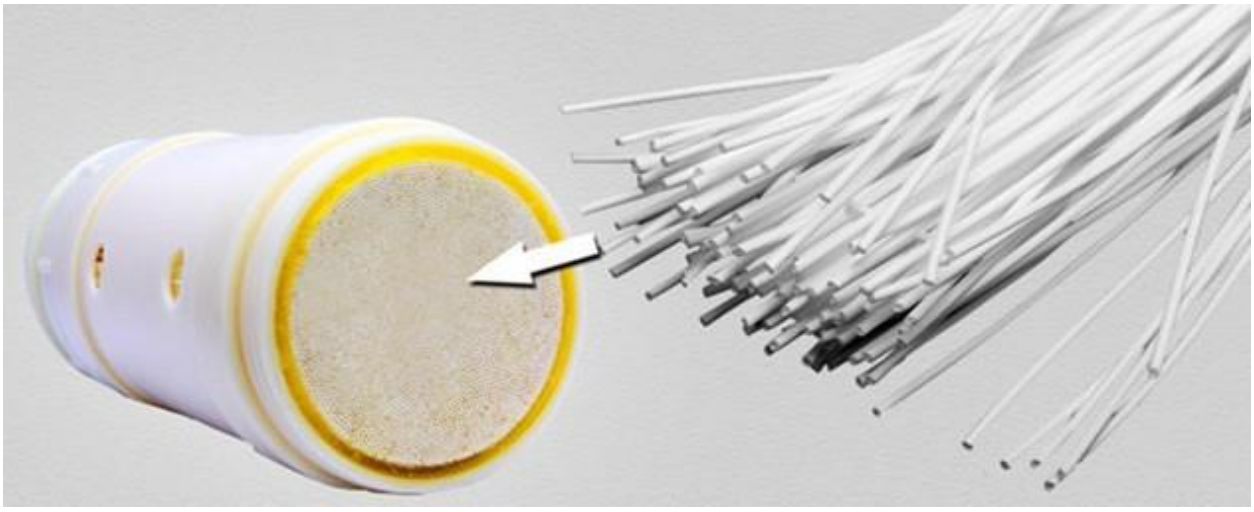
Filtration

From the oxidation/coagulation tank, the water containing the chromium hydroxide and ferric hydroxide solids is fed to a filtration system consisting of membrane filters (i.e., ultrafiltration membranes). The membranes trap the Chrome 3 and iron solids, while allowing the water to pass through as the treated effluent.

Note that conventional media filtration (e.g., sand and/or anthracite) and membrane filters are technologies have been pilot tested and approved by DDW for use in the RCF process for Chrome 6 treatment. Membrane filters generally have a higher cost than conventional media filters; however, they have been demonstrated in potable water filtration applications to be more robust and consistent in removing solids than conventional media filters. Membrane filters also have an established track record of use in the municipal potable water treatment industry. Because of its more robust performance and municipal track record, membrane filters were selected for evaluation in this Feasibility Study.

Membrane filters used for potable water treatment are generally configured as module, with each module housing several thousand hollow fibers membrane strands. Each hollow fiber strand is approximately 1 mm in outside diameter with an internal diameter of approximately 0.6 mm. A typical module showing the hollow fiber membranes is illustrated in Figure 3-2.

Figure 3-2: General Example of Hollow Fiber Membrane Filter Module



Filtration is achieved by the passage of water through the hollow fiber wall – flow can be either outside-in or inside-out and varies depending on the equipment supplier. Multiple modules are mounted in parallel on a skid, with multiple skids operating in parallel to achieve the required treatment capacity.

Treated Effluent Blending and Product Water

The existing literature indicates that the RCF process can produce a treated effluent with a Chrome 6 concentration of 0.003 mg/L or less[1]. For conservativeness, this report assumed a treated effluent concentration of 0.003 mg/L Chrome 6. Since this value is below the identified product water goal of 0.005 mg/L Chrome 6, a portion of the raw water is assumed to bypass the treatment process and blended with the treated effluent in the product water tank to yield a product water at the Chrome 6 treatment goal. Additional sodium hypochlorite is fed into the product water at this point as needed to meet the desired chlorine residual prior to introduction into the potable water system.

Backflush and Membrane Cleaning

Over the course of normal system operation, the chromium hydroxide and ferric hydroxide solids generated in the RCF process collect on the surfaces of the membrane filters. Regular removal of these accumulated solids is necessary to allow continued filter operations and is achieved through the use of routine backflushes and periodic cleanings. These solids removal steps are described as follows:

- Backflush – During a backflush cycle, the filter train to be backflushed is taken offline and isolated from the rest of the treatment system. The flow of water is then reversed through the filter to push the accumulated solids off of the membrane surfaces. Additionally, an air scour is introduced on the feed side of the filter to cause turbulence which aids in the removal of solids from the membrane surfaces. Once the backflush is complete, the solids laden spent backflush water on the feed side of the membrane filter train is drained to a spent backflush tank. The spent backflush is metered into a lamella plate settler to concentrate the solids to a 3% by weight solution. The supernatant from the lamella plate settler is recovered and conveyed to the filter influent. The 3% solids solution is either discharged to waste or sent to further residuals management (i.e., dewatering +

[1] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

hauling offsite of solids to landfill). The filter train is then restored to normal operation. The backflush frequency is highly source water dependent, but generally is performed at 20 minute to 60 minute intervals, with a duration of approximately 2 minutes each.

- Maintenance Clean – This is a periodic chemical clean of the membranes to remove solids on the membrane surfaces that are not effectively removed by backflushing alone. It is performed as chemical soak with a sodium hypochlorite solution at a concentration of approximately 200 mg/L (typical value; membrane manufacturer may advise otherwise depending on effectiveness of cleaning). Upon completion, the spent cleaning solution is neutralized and discharged to waste. The filter train is restore to operation afterwards. Maintenance cleans are generally performed on a weekly to monthly timeframe; the actual interval would be determined on the fouling observed during actual filter system operation.
- Clean-in-Place (CIP) – The CIP is the most rigorous membrane cleaning operation for membrane filters and is intended to remove chemical scale and the more difficult organics that bind themselves to the membrane surfaces. The CIP consists of cycled chemical soaks typically beginning with a low pH cleaning solution (citric acid is often recommended). The spent low pH solution is then flushed from the filter train and followed with a sodium hypochlorite cleaning solution of approximately 1,000 mg/L (typical value; membrane manufacturer may advise otherwise depending on effectiveness of cleaning). Upon completion, the spent cleaning solutions are neutralized and discharged to waste for disposal. The filter train is restore to operation afterwards. CIP operations are generally performed once every 1 to 6 months, depending on the fouling observed during actual filter system operation.

3.1.2 Residuals

The residuals generated from the RCF process consist of solids from the spent backflush that would contain the bulk of the chromium captured by the treatment process, and spent cleaning solutions from maintenance clean and CIP activities. Spent CIP chemicals would be neutralized and discharged to the sewer for disposal. Disposal of the spent backflush solids would be handled through one of two means:

- Discharge to the sewer. This would be the preferred option. However, it would need to be confirmed that the chromium content in these solids would not adversely impact the existing treatment operations and solids handling systems at the Patterson Water Quality Control Facility (WQCF), or affect the classification of the waste solids currently generated at the WQCF.
- If sewer discharge is not an option, the spent backwash solids offsite would require solids dewatering followed by hauling offsite for disposal at a landfill. Additionally, the total chromium concentration of the dewatered solids would be anticipated to exceed the Total Threshold Leachate Concentration (TTLC) limit of 2,500 mg/kg[1]. This would classify the solids as a hazardous waste and would require disposal at a hazardous waste landfill.

Both solids disposal options were evaluated in this Feasibility Study. Note that an analysis of the WQCF treatment and solids management systems for compatibility with the chromium solids generated from an RCF process was not performed, as this is beyond the scope of this project. Such an analysis of the WQCF would need to be addressed in a separate effort.

[1] CCR Title 22, Division 4.5, Chapter 11, Article 3, § 66261.24.

3.1.3 Other Considerations and/or Limitations

The existing work done with RCF for Chrome 6 treatment[1] indicate that the following should be considered when using this technology:

- Careful control over the sodium hypochlorite dosing rate to the oxidation/coagulation tanks is needed. If underdosed, incomplete oxidation of the ferrous iron will result, allowing some iron to bleed into the potable distribution system. If overdosed, it is possible that some of the Chrome 3 could be reoxidized back to Chrome 6.
- RCF is not an effective process will not be effective in to reduce nitrate or TDS present in the source water.

3.1.4 RCF Conceptual Design Criteria

To develop the conceptual level equipment needs and sizing requirements, the design criteria produced from the 2014 Chrome 6 treatment work done at the City of Glendale Operable Unit and City of Livermore were used[1]. These criteria are shown in Table 3-1.

[1] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

Table 3-1: RCF Base Conceptual Design Criteria

Parameter	Unit	Value	Note
Reduction Tank			
Contact Time	min	5	See (a)
Fe:Cr Dosing Ratio	mg:mg	50:1	See (a)
Oxidation/Coagulation Tank			
Contact Time	min	5	See (a)
Sodium Hypochlorite Dosing Rate	mg/L	1.5	See (a)
Polymer Dosing Rate	mg/L	0.1	See (a)
Membrane Filter			
Type	-----	UF	Evoqua 2016
Flux	gal/ft^2/day (gfd)	40	Evoqua 2016
Chrome 6 in RCF Process Treated Effluent	mg/L	0.003	See (a)

Footnotes:
a. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

3.2 Weak Base Anion Exchange (WBA)

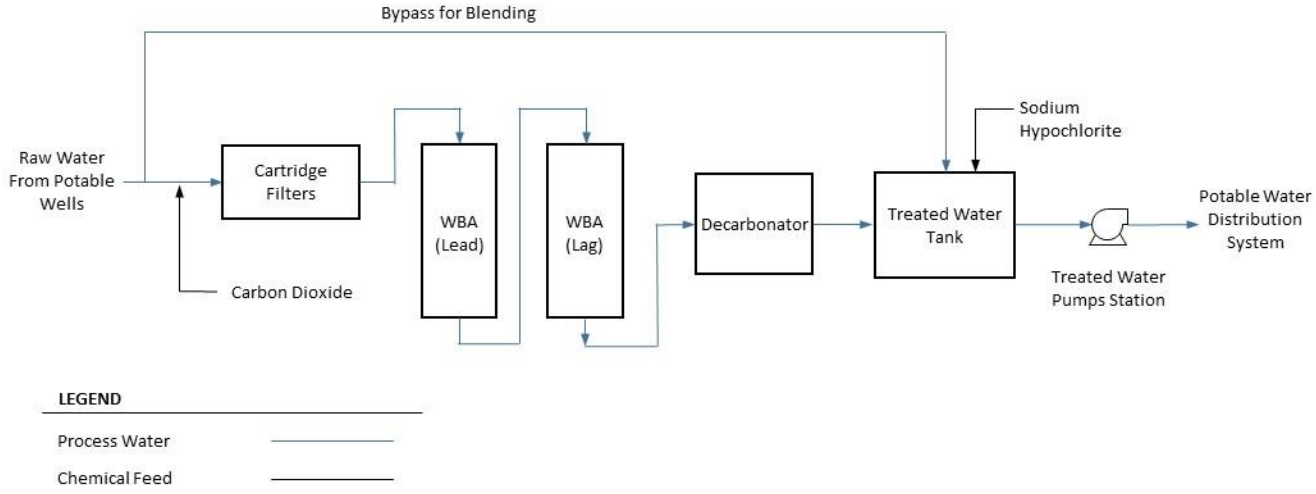
Ion exchange as technology category is a process where raw water is passed through an ion exchange resin bed for treatment. As the water passes through the resin bed, the ions targeted for removal from the water exchange with innocuous ones bound to the charged surfaces of the resin. The targeted ion remains bound to the resin surfaces, while the water exits the resin bed as treated effluent. Operation continues until the ion targeted for removal is observed breaking through in the treated effluent, signaling that the resin has exhausted its removal capacity. Once this occurs, the resin is either replaced or regenerated, followed by restoration to service. The requirement for replacement or regeneration is dependent on the type of ion exchange resin selected for use.

WBA is a type of ion exchange resin. They are made of a synthetic media and consist of porous beads with a high available surface area. These are single use (i.e., non-regenerable), high capacity resins that have a track record in related applications, such as the treatment of perchlorates in potable groundwater. For Chrome 6 treatment, the WBA resins are manufactured of epoxy polyamine or a similar proprietary formulation, and take the physical form of beads that are generally between 0.4 and 1.7 mm in diameter. The charges surfaces of the resin are saturated with chloride ions, which are exchanged for the Chrome 6 (i.e., chromate ions) during treatment. Upon reaching exhaustion, the spent resin is changed out with new, with the spent resin being hauled offsite for disposal as a solid waste.

3.2.1 WBA Treatment Process Steps

Figure 3-3 shows a general process flow diagram for this treatment process.

Figure 3-3: WBA Process Flow Diagram



The following describes each treatment step and its intended function in the overall process.

- The pH of the raw water is lowered to approximately 6 at the influent to the treatment process. The findings from the prior pilot testing at Glendale and Livermore showed that reducing the pH to 6 greatly improved the performance of the WBA resin[1]. This is done by adding carbon dioxide to the water. As the carbon dioxide dissolves, it converts to carbonic acid which allows the reduction of pH.
- The pH adjusted water is passed through a bank of cartridge filters. These are used as a protective measure to prevent headloss buildup in the downstream ion exchange vessel in the event that solids are present the raw water.
- Downstream of the cartridge filters, the raw water is passed through one or more parallel trains of ion exchange vessels. The number of parallel trains needed is determined by the total raw water flow rate. Each train consists of two ion exchange vessels configured in series. In this configuration, the first vessel in series (i.e., the "lead" vessel) treats for all of the Chrome 6 in the water. As the lead vessel becomes exhausted, the Chrome 6 that passes through is then captured by the second vessel in series (i.e., the "lag" vessel). At this point, the lead vessel is taken out of service for resin replacement. The lag vessel is moved into the lead position by reconfiguring of valves in the process pipe manifold. Once the resin change out is complete, the newly serviced vessel is put back into the system as the new lag vessel. The use of the lead/lag configuration is intended to maximize the usable capacity of the resin in the lead vessel before its removal as spent resin for disposal and replacement with new. This configuration is commonly used for other single use resin systems, such as those used for perchlorate treatment.
- The treated effluent from the resin vessel trains are passed through a decarbonator to raise the water pH to its original level. The decarbonator is a forced draft stripping tower used to remove the carbon dioxide from the water and consists of a packed column containing a plastic or a similar inert media with a high surface area. The water is introduced at the top and allowed to cascade on

[1] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015

and through the media to the bottom of the column, with air blown through from the bottom to the top. The high surface area of the media allows for high interfacial contact between the water and the air. As a result, the dissolved carbon dioxide can rapidly degas from the water and discharge to atmosphere, effectively reversing the carbon dioxide injection step applied at the influent of the treatment process.

- The existing literature indicates that the WBA process can produce a treated effluent with a Chrome 6 concentration of less than 0.001 mg/L[1]. For conservativeness, this report assumed a treated effluent concentration of 0.001 mg/L Chrome 6. Since this value is below the identified product water goal of 0.005 mg/L Chrome 6, a portion of the raw water is assumed to bypass the treatment process and blended with the treated effluent in the product water tank to yield a product water at the Chrome 6 treatment goal.
- The final product water is chlorinated as needed to meet the required disinfection residual prior to conveyance to the potable distribution system.

3.2.2 Residuals

Spent cartridge filters and spent resin are the residuals generated from this treatment process. Management of these residuals are discussed below.

Spent Cartridge Filters

Cartridge filters are assumed to be replaced on a weekly interval. They are anticipated to be a non-hazardous solid waste and are assumed to be disposed of in the trash.

Spent WBA Resin

As noted in Chapter 3.1.1, the WBA resin in the lead vessel is used until it becomes exhausted. When this occurs, the lead vessel is taken out of service for a resin change out. Following the change out with new resin, the lag vessel is moved to the lead position and the prior lead vessel is place back into service in the lag position. Resin change outs are anticipated to occur once every 1.8 years, based on a minimum resin capacity of 250,000 bed volumes[1].

Upon removal from the vessel, the spent resin requires dewatering to meet the allowable solids moisture content (i.e. dryness) for disposal at a landfill[2]. This is accomplished by gravity draining the excess free water in the resin followed by the addition of an adsorbent material to meet the solids dryness requirement (this practice is allowed by landfill facilities for moisture control). Performing a material balance using the average raw water Chrome 6 concentration of 0.019 mg/L in Table 2-3, the 250,000 bed volume removal capacity of the resin, and the estimated mass of the spent resin and adsorbent, it is anticipated that the Chrome 6 solids concentration in the spent resin will exceed the Chrome 6 TTLC limit of 500 mg/kg[3]. The spent resin would therefore be classified as a hazardous waste and require disposal at a hazardous waste landfill.

3.2.3 Other Considerations and/or Limitations

The following are additional factors that could affect the decision to consider this treatment process:

1. Chrome 6 WBA resins will remove uranium in addition to Chrome 6 from the water. Since the City's water supply contains a background level of uranium, it will be captured by the resin during Chrome 6 treatment. If the uranium concentration is allowed to exceed 0.05% by weight in the

[1] Evoqua 2016 for ResinTech SIR 700 resin.
[2] Must pass Paint Filter Test (EPA Test Method 9095B)
[3] CCR Title 22, Division 4.5, Chapter 11, Article 3, § 66261.24.

dewatered spent resin, it would be classified as a Low Level Radiological Waste (LLRW)[1]. Note that the addition of an adsorbent to meet the dryness requirement for disposal has a secondary benefit of increasing the inert mass in the spent resin so that the uranium concentration in the solids do not exceed the LLRW threshold. This practice is allowable, as the primary function of the adsorbent is to meet the moisture control requirement to allow for landfill disposal[2].

2. It is assumed for this Feasibility Study that the spent resin will be classified as a hazardous waste and not a LLRW. However, it should be noted that this is based on limited historical data for uranium[3]. If the current background uranium concentrations are higher than historically reported, or if they increase in the future, the 0.05% LLRW threshold could be exceeded. In this were to occur, the City would be subject to the following additional regulatory requirements for disposal of the spent WBA resin[1]:
    a. A general license to allow the handling of solid waste with a uranium concentration in excess of 0.05% by weight. The general license is applicable only if no more than 15 lbs. of uranium are onsite at any given time and less than 150 lbs of uranium is generated by the treatment system in a year. If either limit is exceeded, application for a special license would be required.
    b. A special permit for transportation of low level radiological waste.
    c. The need for a radiological waste compliance officer.
    d. Disposal of the solid waste at a LLRW landfill. The sole facility that can accept this waste from California is in Clive, Utah.
3. Chrome 6 WBA resins are not effective in reducing nitrate or TDS in the source water.

3.2.4 WBA Conceptual Design Criteria

To develop the conceptual level equipment needs and sizing requirements, the design criteria produced from the 2014 Chrome 6 treatment work done at the City of Glendale Operable Unit and City of Livermore were used[4]. These criteria are shown in Table 3-1.

[1] CCR, Title 17, Division 1, Chapter 5, § 30180(c)(2).
[2] Arcadis, Hexavalent Chromium Treatment Residuals Management for ACWA and the City of Glendale Water and Power, March 2012.
[3] Well No. 9 data from June 2010 to March 2015 for gross alpha radiation using gross alpha to uranium conversion factor of 1.5. No gross alpha or uranium data reported for other wells.
[4] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

Table 3-2: WBA Base Conceptual Design Criteria

Parameter	Unit	Value	Note
pH of Adjusted Influent	unit	6.0	See (a)
Cartridge Filters			
Loading Rate per Element	gpm/10" element length	4.8	See (b)
Resin Parameters			
Type	-----	WBA	
Material	-----	Epoxy Polyamine or Equal	See (a)
Empty Bed Contact Time (EBCT)	minute	3	See (a)
Bed Volumes (minimum)	-----	250,000	Evoqua 2016
Chrome 6 in WBA Process Treated Effluent	mg/L	0.001	See (a)

Footnotes:
a. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.
b. Parker, 2016. 2.5" diameter honeycomb cartridge filter elements.

3.3 Strong Base Anion Exchange (SBA)

As an ion exchange process, SBA functions similarly to WBA in that it treats water by exchanging the ion targeted for removal for an innocuous ion bound to the resin as the water is passed through the resin bed. These types of resins have been extensively used in the potable municipal industry for groundwater treatment of constituents such as nitrate and arsenic.

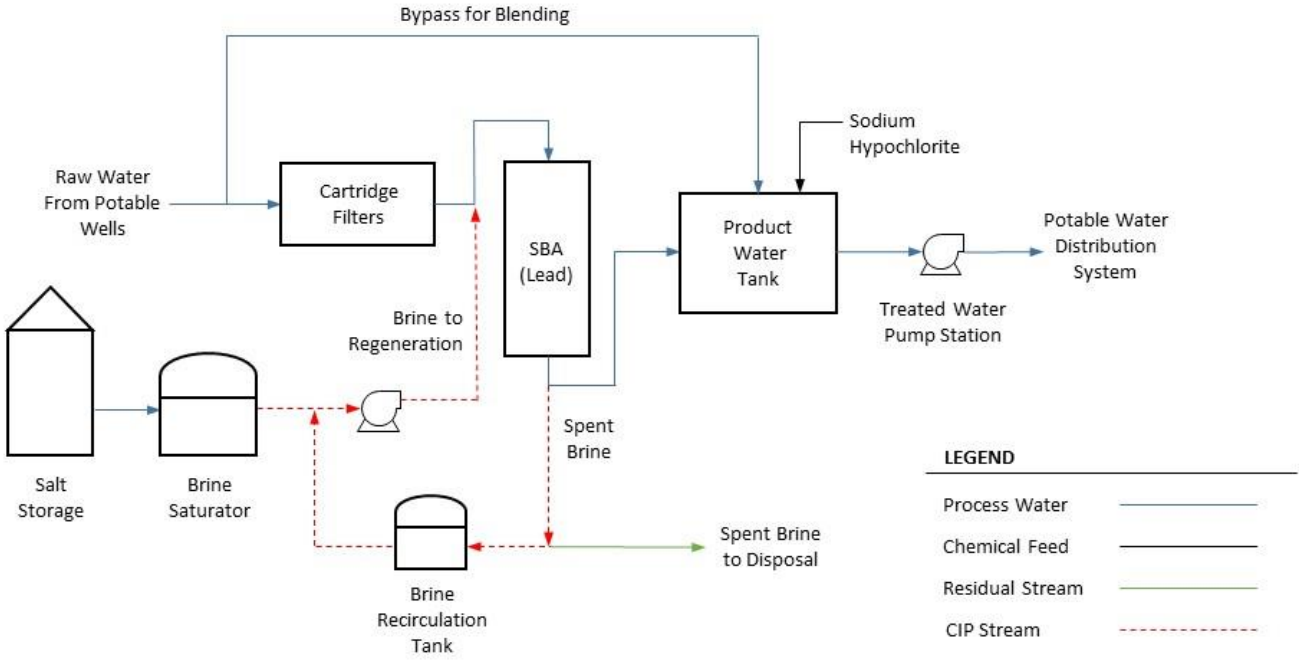
Chrome 6 SBA resins are made up of styrene divinyl benzene or a similar proprietary formulation and physically consist of beads that are generally between 0.3 and 1.2 mm in diameter. Additionally, they differ from WBA resins in the following key areas:

- SBA resins are regenerable. Regeneration is done by soaking the resin in a concentrated solution of sodium chloride (brine), where the Chrome 6 is transferred to the brine solution and the resin surfaces become resaturated with chloride ions. The spent brine solution is disposed of as a liquid waste at the completion of the regeneration cycle.
- They have a much lower Chrome 6 capacity than WBA resins. This is generally offset by the ability to regenerate the resin bed.
- Chrome 6 SBA resins remove sulfate and nitrate in addition to Chrome 6 and uranium. The concurrent removal of these constituents reduces the available capacity of the resin to remove the Chrome 6 and increase the frequency of regeneration.

3.3.1 SBA Treatment Process Steps

The SBA treatment process consists of two main operations: Chrome 6 treatment of the water through the SBA resin vessels followed by blending with water bypassing the treatment process to meet the treated effluent goal; and the regeneration of the spent resin with the regeneration system when the resin capacity is exhausted. Figure 3-4 shows a general process flow diagram for the overall treatment process.

Figure 3-4: SBA Process Flow Diagram



Each step of the treatment process is described below.

Chrome 6 Treatment

- pH adjustment is not needed for the SBA resin, so raw water initially feeds into a cartridge filter system to remove any suspended solids that could cause an buildup of head loss across the resin media.
- The water next feeds into one or more parallel vessels containing the Chrome 6 SBA resin. The number of parallel vessels needed is dictated by the treatment flow. The lead/lag duplex vessel configuration applied to the WBA treatment system is not used for SBA.
- The existing literature indicates that the SBA process can produce a treated effluent with a Chrome 6 concentration of less than 0.001 mg/L[1]. For conservativeness, this report assumed a treated effluent concentration of 0.001 mg/L Chrome 6. Since this value is below the identified product water goal of 0.005 mg/L Chrome 6, a portion of the raw water is assumed to bypass the treatment process and blended with the treated effluent in the product water tank to yield a product water at the Chrome 6 treatment goal.

[1] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

- The final product water is chlorinated as needed to meet the required disinfection residual prior to conveyance to the potable distribution system.

Regeneration

The regeneration process is performed when the resin in a vessel reaches exhaustion. When this occurs, the vessel is taken out of service and isolated from the system. A regeneration cycle is then started, which consists of circulating a concentrated sodium chloride solution (brine) through the spent resin. The brine forces the Chrome 6, nitrate, sulfate, and uranium off of the resin surfaces and into the brine solution, while resaturating the surfaces with chloride ions. When the regeneration cycle is complete, the vessel is restored to operation. The spent brine sent to disposal as a waste stream.

The regeneration system generally consists of a bulk salt (sodium chloride) storage tank, a brine saturator, and a brine recirculation tank. Bulk salt is delivered via truck and loaded into the salt storage tank. The brine tank contains water with an excess mass of salt. The water steeps in the salt allowing it to generate the concentrated salt solution (brine) needed for regeneration. When a regeneration cycle is started, the brine solution is pumped from the brine tank and circulated into the vessel being regenerated. The brine used in the process is discharged into the brine recirculation tank and looped back into the vessel undergoing regeneration until the regeneration cycle is complete. At the completion of the regeneration cycle, the spent brine is discharged from the system for disposal. After each regeneration cycle, water is added to the brine saturator as well as additional bulk salt to make up for the quantities consumed during regeneration. Periodic deliveries of bulk salt are needed to restore the quantities consumed through regeneration.

3.3.2 Residuals

Spent cartridge filters, spent brine from regeneration, and spent resin are the primary residuals generated from this treatment process. Management of these residuals are discussed below.

Spent Cartridge Filters

Cartridge filters are assumed to be replaced on a weekly interval. They are anticipated to be a non-hazardous solid waste and are assumed to be disposed of in the trash.

Spent Brine

The primary residual from the SBA process is spent brine from regeneration. The TDS of the brine is anticipated to be in excess of 10,000 mg/L, consisting mostly of sodium chloride and the chromium removed from the water during the treatment process. Discharge of the spent brine to the City sewer system for disposal is the preferred option, if waste streams at this TDS can be accepted at the Patterson WQCF. It is unclear if the high TDS brine will impact the existing treatment operations or if it would create compliance issues with the plant's Waste Discharge Requirements (WDR) Order R5-2007-0147. If discharge to the sewer is not allowable, other potential disposal options include hauling offsite for disposal as liquid waste and disposal to evaporation ponds. These options, and the extent of their evaluation in this report, are as follows:

1. Liquid Waste Disposal – For this disposal alternative, the spend brine would be hauled offsite to a liquid waste disposal facility. For this Feasibility Study, it was assumed that spent brine would be hauled to East Bay Municipal Utility District (EBMUD) for disposal. Costs for hauling and disposal were estimated as a O&M cost under this disposal option. Note that initial discussions with EBMUD had indicated that they have reservations regarding receiving liquid waste with chromium and may not be willing to accept the spent brine into their system. Further discussions with EBMUD would be necessary if SBA with hauling to EBMUD for spent brine disposal is considered beyond this Feasibility Study level.

2. Evaporation Ponds – The use of evaporation ponds for disposal, as considered in this Feasibility Study, was limited to estimating the acreage required to accommodate the spent brine volume generated from the treatment process. Costs were not developed for this disposal option due to unknowns associated with pond location(s) and required support infrastructure. Estimates of the required pond acreage were based on rainfall and evapotranspiration data obtained from the California Irrigation Management Information System (CIMIS) Patterson monitoring station (Station 161) for the 5 year period from September 2011 through September 2016.

Spent SBA Resin

A second residual generated from the SBA process is spent SBA resin. Although regenerable, SBA resins have a finite life and are expected to require replacement at an approximate interval of 7 years[1]. The spent resin is expected to be a non-hazardous solid waste and would be hauled to a landfill for disposal.

3.3.3 Other Considerations and/or Limitations

The existing work done with SBA for Chrome 6 treatment[2] indicate that the following should be considered when using this technology:

1. SBA resins for Chrome 6 treatment also remove sulfate and nitrate in addition to Chrome 6 and uranium. Additionally, these type of resins are prone to a phenomenon known as nitrate "dumping". The following describes this phenomenon:

    a. During the initial period of operation with a fresh resin bed, sulfate and nitrate are exchanged for chloride on the resin. Very little or no sulfate and nitrate will be present in the treated effluent at this stage of operation.

    b. When the resin reaches saturation with both of these ions, the resin will no longer remove nitrate. The nitrate concentration in the treated effluent will quickly climb until it reaches the influent concentration.

    c. The sulfate in the influent will continue to be removed by displacing the nitrate bound to the resin surfaces. This displaced nitrate is released or "dumped" into the treated effluent, adding to the background nitrate present in the influent that is now passing through the resin. The nitrate dumping causes the treated effluent nitrate concentration to be higher than the influent.

    d. The nitrate dumping will continue until the nitrate on the resin is completely displaced by sulfate. At this point, the nitrate in the treated effluent will decrease until it equals the influent concentration. This phenomenon has the potentially to cause regular increases in nitrate in the final product water above the nitrate MCL of 45 mg/L.

    To prevent the nitrate in the treated effluent from exceeding its MCL, the product water tank was sized to capture the volume from at least one full treatment cycle for the system (i.e., total volume of water treated between regenerations).

2. Although nitrate is initially removed by SBA resins, the nitrate "dumping" quickly releases the nitrate back into the treated effluent. Therefore, this treatment process will be ineffective for treating nitrate. This process is also ineffective for treating TDS.

[1] Wigen Water Technologies 2016.
[2] Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

3.3.4 SBA Conceptual Design Criteria

To develop the conceptual level equipment needs and sizing requirements, the design criteria produced from the 2014 Chrome 6 treatment work done at the City of Glendale Operable Unit and City of Livermore were used. These criteria are shown in Table 3-3.

Table 3-3: SBA Base Conceptual Design Criteria

Parameter	Unit	Value	Note
Cartridge Filters			
Loading Rate per Element	gpm/10" element length	4.8	See (a)
Resin Parameters			
Type	-----	SBA	
Material	-----	Styrene DVB	See (b)
Empty Bed Contact Time (EBCT)	minute	4.5	See (c)
Bed Volumes	-----	210.3	See (d)
Treated Effluent Tank Size (minimium)	Bed Volumes	210.3	To mitigate nitrate dumping
Chrome 6 in SBA Process Treated Effluent	mg/L	0.001	See (b)

Footnotes:

a. Parker, 2016. 2.5" diameter honeycomb cartridge filter elements.
b. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.
c. Evoqua, 2016 for 10' diameter model PTI vessels with SBA resin.
d. Water Research Foundation, Impact of Water Quality on Hexavalent Chromium Removal Efficiency and Cost, 2014.

As noted earlier, SBA resins will simultaneously remove a number of ions in addition to Chrome 6. The prior work cited in the literature showed that Chrome 6 SBA resins have a high affinity for sulfate and nitrate. The findings also indicate that the resin capacity available for Chrome 6 treatment is highly dependent on the influent sulfate and nitrate concentrations, and generated the following correlation for the Chrome 6 resin capacity as a function of these constituents[1]:

Chrome 6 SBA Capacity (bed volumes) = 6,541 – 8,307.5*log{ (sulfate/48) + (nitrate/62) }

Where sulfate and nitrate are influent concentrations in units of mg/L.

Given the average concentrations for these constituents established in Table 2-3, this equation yielded an estimated 210.3 bed volumes of available Chrome 6 treatment capacity before regeneration is needed. This translates to a regeneration frequency of once every 10.5 hours per treatment vessel, assuming a recommended empty bed contact time (EBCT) of 3 minutes. The estimated number of bed volumes and regeneration frequency were confirmed through discussions with vendors associated with the Chrome 6 work done at the Glendale Operable Unit.

The existing literature is unclear on when nitrate dumping may occur in the Chrome 6 treatment cycle (i.e., time between regenerations). Therefore, it is assumed for this analysis that it will occur and that must be

[1] Water Research Foundation, Impact of Water Quality on Hexavalent Chromium Removal Efficiency and Cost, 2014.

mitigated to prevent the nitrate MCL from being exceeded. Therefore, the treated water tank for each SBA alternative will be sized to contain at least 210.3 bed volumes of water.

3.4 Reverse Osmosis (RO)

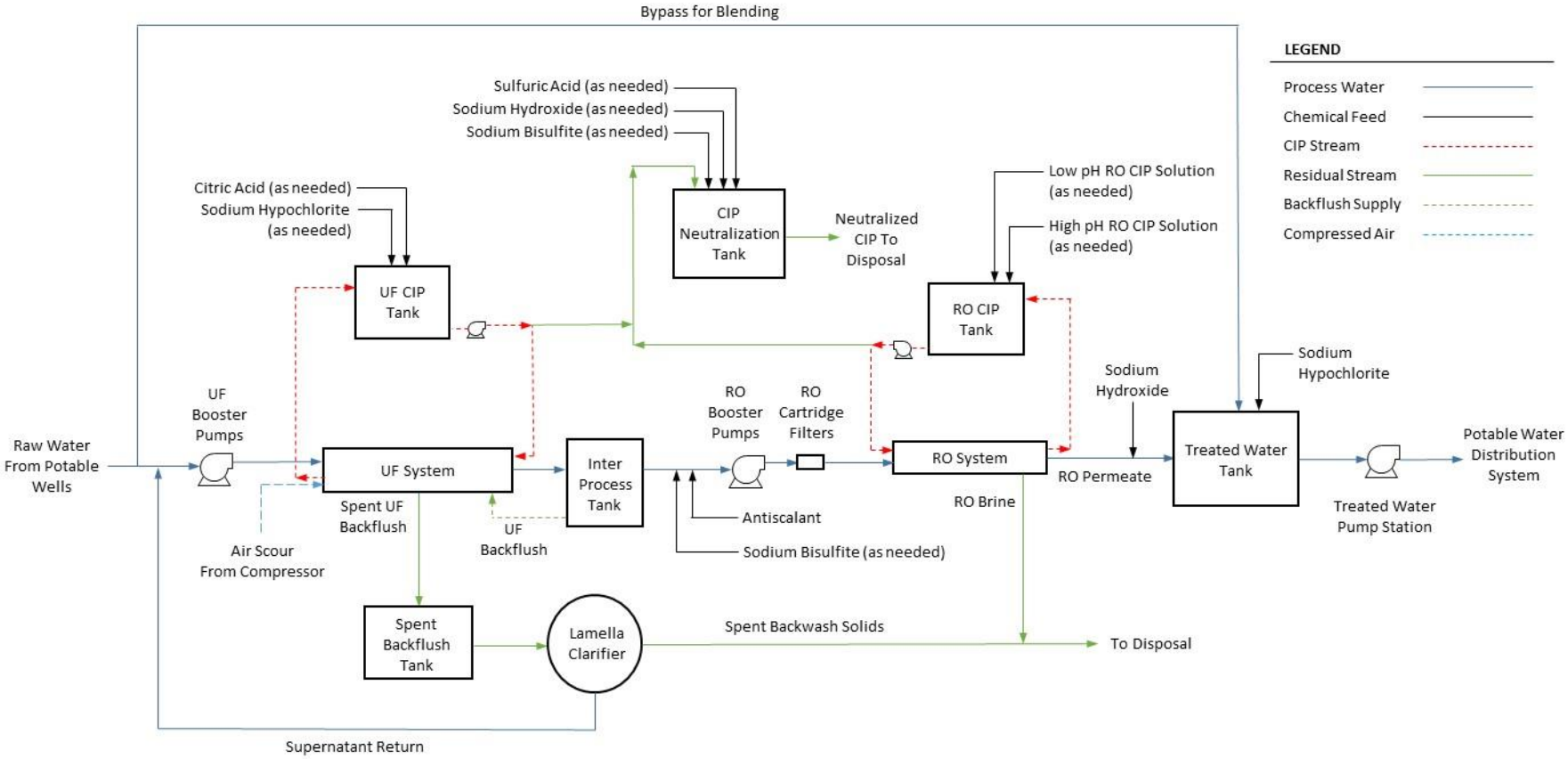
RO is a treatment process that uses a semi-permeable thin film composite (TFC) membrane to separate water from the ions and large molecular weight molecules dissolved in the water (i.e., the raw water TDS). RO membranes for large scale municipal water treatment applications are configured in an industry standard 8-inch diameter spiral wound element that is 40-inches in length, and typically have 400 square feet of membrane surface per element. Between 5 and 7 elements in series are loaded into a horizontal pressure vessel for operation. Multiple parallel pressure vessels are then used to achieve the treatment capacity needed for the application.

Operationally, raw water is introduced to the feed side of the RO membrane under pressure. When the applied pressure exceeds the osmotic pressure of the membrane, water on the feed side begins to pass through as permeate. The permeate has a very low TDS and is collected as the treated effluent from the process. The bulk of the TDS present in the source water cannot pass through and is left to concentrate in the water remaining on the feed side of the membrane. The TDS continue to concentrate in the diminishing volume of water on the feed side of the membrane until it exits the treatment process as brine. The brine is discharged to disposal as a waste stream.

3.4.1 RO Treatment Process Steps

Figure 3-5 shows a general process flow diagram for the overall RO treatment process.

Figure 3-5: RO Process Flow Diagram



The following describe the process steps shown in Figure 3-5.

- The feed water is initially pretreament for colloidal solids. Table 2-3 showed the estimated potable system source water turbidity to be between 0.2 to 6.2 NTU, with an average of 2.1 NTU. Given that this turbidity is higher than desirable for a feed water to an RO system, a UF process was included as a pretreatment step to protect the RO membranes against damage that could be caused by colloidal solids. This process is the same as the UF treatment component described in Chapter 3.1.1 for the RCF process, and requires backflushing, maintenance cleans, and CIP as described previously.
- The effluent from the UF process is discharged to an interprocess tank. This tank serves two functions: to provide backflush supply water to the UF system and to act as a pressure and flow buffer between the UF and RO systems. This buffer is needed protect the RO system from transient pressure shocks that occur when UF trains are rapidly taken out of/placed back into service as part of backflushing activities. Repeated exposure of the RO membranes to such pressure shocks could reduce the life of the membrane elements.
- The feed water is dechlorinated, if needed. This step would be needed if a free chlorine is provided at the wells before treatment by RO, as free chlorine will damage the RO membrane. In this case, sodium bisulfite would be added to neutralize the chlorine upstream of the RO process.
- The feed water is pretreated with an antiscalant chemical to minimize the potential for scale formation. The use of an antiscalant increases the solubility of sparingly soluble salts present is the source water, such as calcium carbonate and silica compounds. When the solubility limits of these salts are exceeded, they form scale on the membrane surfaces that rapidly degrade RO performance. Consequently, the solubility limits of these salts set the recovery achievable by the RO system (i.e. the percent of permeate extracted from the raw water fed to the RO system). By raising the solubility limits of these salts with the antiscalant, the recovery of the RO process can be increased.
- The feed water is passed through cartridge filtration. This is done as a backup measure to protect the RO membranes against suspended solids.
- Feed water is treated by the RO system, separating the water into a low TDS permeate stream and a high TDS brine stream.
- The permeate is post-treated to mitigate corrosiveness. This is done by raising the permeate pH to a range where the Langlier Saturation Index (LSI – measure of corrosivity) is neutral. Sodium hydroxide is added to the permeate as needed to achieve a neutral LSI value.
- RO membranes have been cited to reject 85% to 95% of the Chrome 6 (as chromate ion) present in the feed water[1]. For conservativeness, this report assumed a Chrome rejection of 85%. Based on the average Chrome 6 concentration of 0.0199 mg/L for the potable system from Table 2-3, the Chrome 6 concentration in the RO permeate would be 0.003 mg/L. Since this value is below the identified product water goal of 0.005 mg/L Chrome 6, a portion of the raw water is assumed to bypass the treatment process and blended with the treated effluent in the product water tank to yield a product water at the Chrome 6 treatment goal.

[1] Watertreatmentguide.com, Nominal Rejection Characteristics of Thin Film Composite Reverse Osmosis Membranes.

- The final product water is chlorinated as needed to meet the required disinfection residual prior to conveyance to the potable distribution system

3.4.2 Residuals

The primary residuals anticipated from the RO treatment process include the following:

- Spent backflush water and solids. Spent backflush is sent to lamella plate settlers to recover a portion of the water and concentrate the solids to a 3% solution. The 3% solids solution is expected to be discharge to sewer for disposal. It will not contain chromium, as is the case for the UF in the RCF process, and should therefore not present any issues to the solids currently generated at the Patterson WQCF.
- Spent cleaning solutions from the UF maintenance cleans and CIP. The spent solutions for each are expected to be neutralized and discharged to the sewer for disposal.
- Brine from the RO system. The brine is expected to have a TDS ranging from approximately 4,650 mg/L based on the average water quality data to as high as approximately 5,600 mg/L using the water quality maximum values. RO brine would be discharged to the sewer for disposal as the preferred option. If sewer disposal is not allowable, the acreage required for disposal to evaporation ponds was estimated. Note that estimating the costs for evaporation ponds as a disposal option is beyond the scope of this report and would need to be addressed in a separate effort. RO brine disposal through liquid waste hauling was not considered as an option due to the large volumes generated from this treatment process.

3.4.3 Other Considerations and/or Limitations

In meeting the Chrome 6 goal of 0.005 mg/L, the RO process will also reduce the nitrate to approximately 7.5 mg/L and TDS to approximately 150 mg/L. These concentrations are significantly lower than their MCLs of 45 mg/L and 500 mg/L, respectively.

3.4.4 RO Conceptual Design Criteria

The base design criteria were used to determine the conceptual equipment requirements for the RO treatment system alternative are presented in Table 3-4.

Table 3-4: RO Base Conceptual Design Criteria

Parameter	Unit	Value	Note
UF Pretreatment			
Flux	gal/ft^2/day (gfd)	40	Evoqua 2016
Cartridge Filters			
Loading Rate per Element	gpm/10" element length	4.8	See (a)
RO System			
Antiscalant	mg/L	3	
Recovery	minimum	80%	
Recovery	average	82%	See (b)
Sodium Hydroxide for Permeate Post-Treatment	mg/L	20	See (b)
Chrome 6 in RO Permeate	mg/L	0.003	Based on 85% chromate ion rejection

Footnotes:
a. Parker, 2016. 2.5" diameter cartridge filter elements.
b. IMS-Design modeling software.

3.5 Treatment Siting Options

The siting alternatives considered for this Feasibility Study include siting at the individual wellheads and treatment at a single centralized facility. These options are described below.

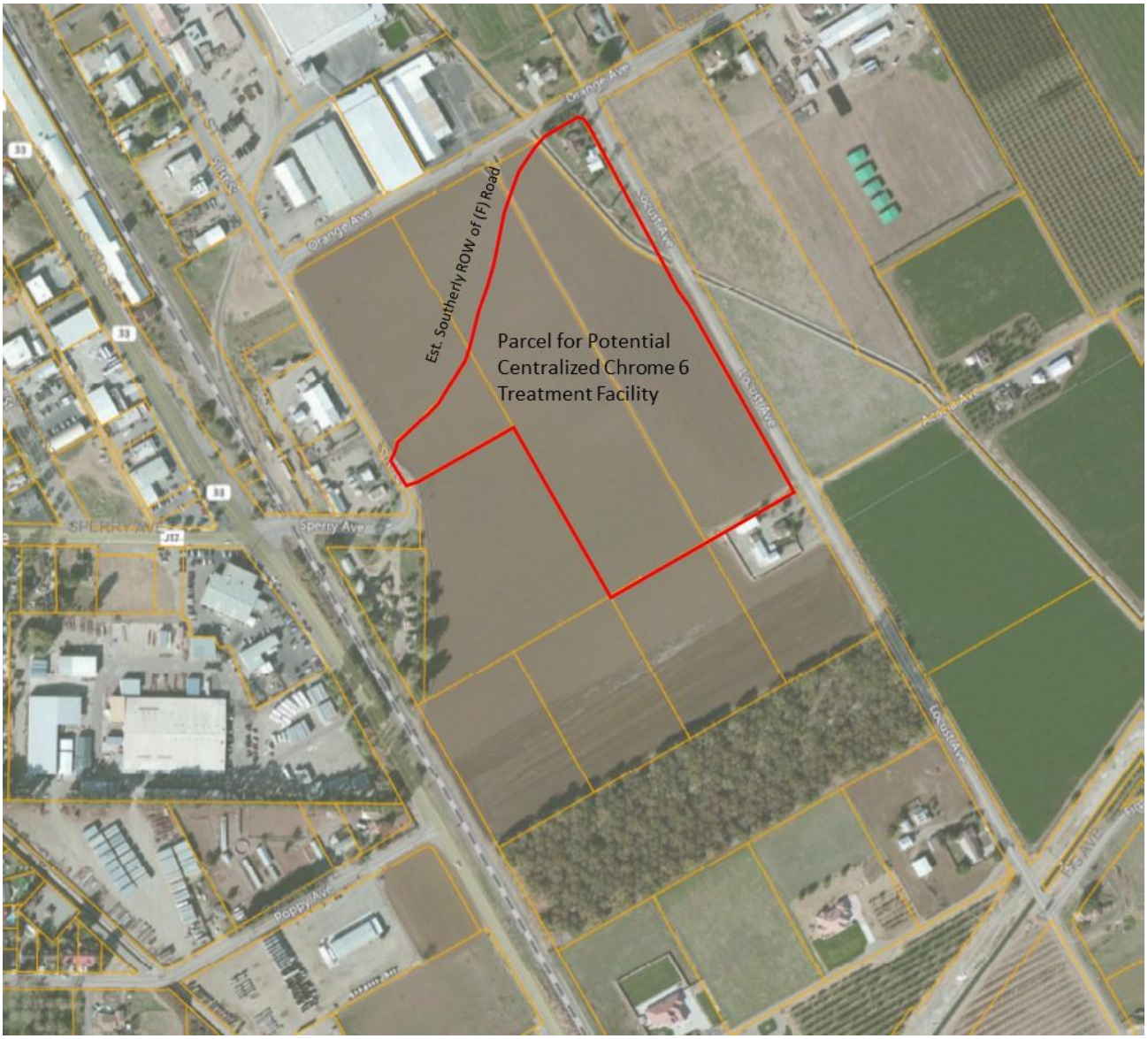
Wellhead Siting

Wellhead siting would entail locating a treatment system at each potable well location. For this evaluation, this would consist of placing individual treatment systems at the locations for Wells No. 2, 5, 6, 7, 8, 9, and 11. To assess logistical feasibility, a comparison of the estimated space needed for each treatment alternative against the space available at each well site location was performed. Sites with insufficient or marginal space availability were identified as not feasible. As per the scope of work of this project, layouts were not generated for the wellhead siting options.

Centralized Treatment Siting

The parcel originally identified by the City for a potential centralized facility was bound by 1st Street on the west, Orange Ave. to the north, and Locust Ave. on the east. However, a future public roadway will be constructed along the north side of the parcel, defining a new boundary for that side of the parcel. The revised parcel boundary with the estimated southerly right-of-way for the future roadway is shown in Figure 3-6.

Figure 3-6: Revised Centralized Treatment Facility Parcel



For the analysis of the centralized treatment facility site options, a layout for each treatment technology option was developed to show space requirements and conceptual equipment arrangements on the parcel. These layouts and equipment requirements are presented in Chapter 5.

Chapter 4 Well Head Treatment Analysis

This Chapter provides the major equipment requirements and a parametric estimate of the space requirements of the conceptual level system for each of the well head treatment options. The well sites evaluated for the well head siting options include Wells No. 2, 5, 6, 7, 8, 9, and 11. As a basis for developing the conceptual space requirements for each technology and the estimated space available at each wellhead location, the following methodology was used:

- The total space on the parcel for each wellhead location was provided by the City. The space available for a wellhead treatment system was then estimated by subtracting the approximate square footage occupied by existing infrastructure. The approximate space occupied by existing infrastructure was measured from current aerial photos.
- The requirements for a 1,000 gpm RCF system were developed for use as a standard reference for the wellhead sites. To conduct the parametric estimate of space required, the base footprint for all of the major equipment items for the reference system were estimated and summed. This was followed by the application of a scale up factor to the total space for the major equipment to estimate the actual space for a complete facility (i.e., to account for the additional space required for site access; ancillary and support equipment; and clearances for facility operations and maintenance). As a basis for developing a suitable scale up factor, the equipment layout for the Santa Clara Valley Water District (SCVWD) Site 2 Advanced Water Purification Facility (AWPF) was used and is presented in Table 4-1.

Table 4-1: Scale Up Factor for Well Head System Footprint Estimation

Item	Unit	Value
MF System		
MF	SF	5,400
MF CIP	SF	4,000
Interprocess Tank	SF	5,750
RO System		
RO	SF	4,275
RO CIP	SF	2,200
Decarbonators	SF	2,250
AOP	SF	2,100
Chemical Storage		
Sodium Hydroxide	SF	750
Sodium Bisulfite	SF	600
Calcium Chloride	SF	1,200
Sulfuric Acid	SF	600
RO Antiscalant	SF	600
Hydrogen Peroxide	SF	600
Total Primary Process Equipment	SF	30,325
Total Facility (SCVWD Site 2 AWPF)	SF	172,125
Base Scale Up Factor[a]		5.68
Safety Margin		20%
Final Scale Up Factor		**6.81**

Footnotes:

a. Total facility footprint for SCVWD APWF divided by total space for primary process equipment.

- For Well No. 2, the fraction of the well capacity requiring treatment and the fraction to bypass were estimated. This split was based on meeting a final treated water goal of 0.005 mg/L Chrome 6 for the blended product water.
- A system design flow rate for the portion of flow requiring treatment was selected. The design flow rate was selected to the nearest 500 gpm increment (i.e., 500, 100, 1,500 gpm, etc.) equal or greater than the required flow rate for treatment identified in Step 3.
- The 1,000 gpm reference system footprint was adjusted linearly based on the selected design flow rate.
- Steps 2 through 5 were repeated for Wells No. 5, 6, 7, 8, 9, and 11. The estimated space requirement for wellhead RCF system was then compared against the estimated available space at each wellhead site.
- Steps 2 through 6 were repeated for the WBA, SBA, and RO treatment technologies.

The available space at each well site was then compared against the conceptual space requirements of each wellhead treatment system. This comparison provided the basis for assessing the logistical feasibility of each technology by wellhead location. These findings are presented below.

4.1 Reduction-Coagulation-Filtration (RCF)

The reference conceptual wellhead RCF treatment system used for this analysis consists of the primary system components and operating criteria as indicated in Table 4-2. It presents two potential variations of the reference system: one which assumes disposal of all residuals to the sewer, and a second which assumes backflush solids cannot be discharged to the sewer and must be handled onsite for hauling to a landfill for disposal.

Table 4-2: Wellhead RCF System Components and Operating Criteria

Parameter	Unit	Value	Note
Treatment Flow	gpm	1,000	
Primary System Components			
Reduction Process			
Reduction Tank	gal	1 x 5,000	See (a)
Ferrous Sulfate Tank	gal	1 x 1,000	
Oxidation/Coagulation Process			
Oxidation/Coagulation Tank	gal	1 x 5,000	See (a)
Sodium Hypochlorite Storage	gal	2 x 300	300 gal totes
Polymer Tank	gal	1 x 100	Day Tank
Membrane Filter			
Type	-----	UF	
No. of Trains	-----	2	See (a)
Modules per Train	-----	24	See (a)
Total Modules	-----	48	
Backflush Supply Tank	gal	1 x 5,000	
Spent Backflush Tank	gal	1 x 50,000	12 hr storage
CIP Tank	gal	1 x 1,000	
CIP Neutralization Tank	gal	1 x 1,000	
Lamella Plate Settler			See (b)
No. of Units	-----	1	
Feed Flow Rate (each)	gpm	50	
Product Water Tank	gal	1 x 5,000	
Solids Management (if no sewer option)			
Sludge Storage Tank	gal	1 x 1,000	1 week min. storage
Screw Press	gpm	1 x 3.3	See (c)
Solids Bin	CY	1 x 18	See (e)
Primary Operating Parameters			
Chemical Dosing			
Ferrous Sulfate	mg/L	2.7	See (d)
Sodium Hypochlorite	mg/L	1.1 - 1.5	See (d)
Polymer	mg/L	0.1	See (d)
UF Backflush			
No. per day per UF Train	-----	48	See (a)
Total per day	-----	96	
Volume per Backflush	gal	1,000	See (a)
UF Maintenance Clean Frequency	-----	1/week	
UF CIP Frequency	-----	1/month	
Screw Press Operation	hrs per week	3.2	See (c)

Footnotes:

a. Evoqua 2016, RX-5000 for reaction tanks and Vantage Model UFI23-D2 for UF system.
b. WesTech SuperSettler Model PSS15.
c. FCK Screw Press Model BHX 200.
d. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.
e. Baker 2016, 18 CY roll off bin.

Table 4-3 presents the estimated space requirements for the reference RCF treatment system presented in Table 4-2.

Table 4-3: Estimates of RCF Space Requirement for 1,000 gpm Reference System

Parameter	Footprint (SF)
Reduction Process	
Reduction Tank	126
Ferrous Sulfate Tank	64
Oxidation/Coagulation Process	
Oxidation/Coagulation Tank	126
Sodium Hypochlorite Storage	32
Polymer Tank	12
Membrane Filter (UF)	194
Backflush Supply Tank	144
Spent Backflush Tank	729
CIP Tank	
CIP Neutralization Tank	
Lamella Plate Settler	70
Product Water Tank	144
Subtotal with Sewer for Solids Disposal	*1,641*
Solids Management (if no sewer option)	
Sludge Storage Tank	64
Screw Press	81
Solids Bin	144
Subtotal with Solids Handling and Offsite Disposal	*1,786*
Scale Up Factor[a]	6.81
System Space Requirement	
With Sewer for Solids Disposal	11,176
With Solids Handling and Offsite Disposal	12,164

Footnotes:

a. Based on Santa Clara Valley Water District Site 2 Advanced Water Purification Facility.

The reference footprint was scaled up or down in increments of 50% to estimate the space requirement for a system to accommodate the treatment flow rate at each wellhead site. Table 4-4 presents a summary of the flow rates for each well site and compares the space available versus the conceptual treatment system space requirements.

Table 4-4: Wellhead RCF System Treatment Flows and Footprint Evaluation

Item	Well No.						
	2	5	6	7	8	9	11
Flow Rates (gpm)							
Well Capacity	800	1,400	600	1,500	1,000	800	1,200
Minimum Treatment Flow	685	1,191	526	1,401	865	683	1,006
Bypass	115	209	74	99	135	117	194
System Design Treatment Flow	1,000	1,500	1,000	1,500	1,000	1,000	1,500
Total Parcel Size (SF)	15,766	2,200	16,792	9,583	60,113	40,190	58,806
Estimated Available Space on Parcel (SF)	**14,875**	**1,614**	**16,292**	**7,465**	**51,644**	**38,110**	**56,756**
Minimum System Footprint (SF)							
With Sewer Disposal for Solids	11,176	16,764	11,176	16,764	11,176	11,176	16,764
With Solids Handling and Offsite Disposal	12,164	18,246	12,164	18,246	12,164	12,164	18,246
Sufficient Space Available on Parcel?							
With Sewer Disposal for Solids	Yes	No	Yes	No	Yes	Yes	Yes
With Solids Handling and Offsite Disposal	Marginal	No	Yes	No	Yes	Yes	Yes

As noted in Chapter 3.1.1, the treated effluent from the RCF process is assumed to have a Chrome 6 concentration of 0.003 mg/L. The minimum treatment flow and bypass flows indicated in Table 4-4 represent the split of flows to allow the blended product water to meet the final treated water goal of 0.005 mg/L. The methodology used to develop the balance of the information shown in Table 4-4 was presented at the front end of Chapter 4.

Comparing the estimated parcel space available against the conceptual system footprint yielded the following findings:

a. The sites at Wells No. 6, 8, 9, and 11 appear to have sufficient space for a wellhead RCF treatment system.

b. The sites at Wells No. 5 and 7 do not have adequate space for an RCF wellhead treatment system.

c. The site at Wells No. 2 appears adequate to marginal, meaning that the space available is very close to the conceptual RCF system footprint required. A more detailed evaluation of this site would need to be conducted to determine if a treatment system can be fit on the space available at the well location.

4.2 Weak Base Anion Exchange (WBA)

The reference conceptual wellhead WBA treatment system used for this analysis consists of the primary system components and operating criteria as indicated in Table 4-5.

Table 4-5: Wellhead WBA System Components and Operating Criteria

Parameter	Unit	Value	Note
Treatment Flow	gpm	1,000	
Primary System Components			
Carbon Dioxide Storage			See (a)
Capacity	ton	1 x 25	
Tank Configuration	-----	Horizontal	
Diameter x Length	feet	7.3 x 33	
Cartride Filter Vessel			See (b)
No. of Units	-----	1	
Cartridge Filter Elements per Vessel	No.	52	
Element Diameter	inch	2.5	
Element Length	inch	40.0	
WBA System			See (c)
No. of Treatment Trains	-----	1	
No. of Vessels per Train	-----	2	
Operating Configuration	-----	Lead/Lag	
Vessel Diameter	feet	10	
Resin Volume per Vessel	cubic feet	424	
Decarbonator			See (d)
No. of Units	-----	1	
Length x Width X Height	feet	3 x 4 x 10	
Product Water Tank	gal	1 x 5,000	
Primary Operating Parameters			
Resin Change Out Frequency	year	1.8	
Cartridge Filter Replacement Interval			
Carbon Dioxide Feed Rate	lbs/day	1,600	

Footnotes:

a. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015, for estimated tonnage required.
b. Parker Model 6LMP52H-4-8FK1.
c. Evoqua HP1020IX duplex unit.
d. WesTech Aluminum Draft Aerator.

Table 4-6 presents the estimated space requirements for the reference WBA treatment system presented in Table 4-5.

Table 4-6: Estimates of WBA Space Requirement for 1,000 gpm Reference System

Parameter	Footprint (SF)
Carbon Dioxide Storage[a]	216
Cartride Filter Vessel	50
WBA System	594
Decarbonator	30
Product Water Tank	144
Subtotal Major Equipment	*1,034*
Scale Up Factor[b]	6.81
System Space Requirement	7,043

Footnotes:

a. Tomco Systems Model 2681EA CO_2 storage tank.
b. Based on Santa Clara Valley Water District Site 2 Advanced Water Purification Facility.

The reference footprint was scaled up or down in increments of 50% to estimate the space requirement for a system to accommodate the treatment flow rate at each wellhead site. Table 4-7 presents a summary of the flow rates for each well site and compares the space available versus the conceptual treatment system space requirements.

Table 4-7: Wellhead WBA System Treatment Flows and Footprint Evaluation

Item	Well No.						
	2	5	6	7	8	9	11
Flow Rates (gpm)							
Well Capacity	800	1,400	600	1,500	1,000	800	1,200
Minimum Treatment Flow	599	1,036	468	1,314	761	596	866
Bypass	201	364	132	186	239	204	334
System Design Treatment Flow	1,000	1,500	500	1,500	1,000	1,000	1,000
Total Parcel Size (SF)	15,766	2,200	16,792	9,583	60,113	40,190	58,806
Estimated Available Space on Parcel (SF)	**14,875**	**1,614**	**16,292**	**7,465**	**51,644**	**38,110**	**56,756**
Minimum System Footprint (SF)	7,043	10,564	3,521	10,564	7,043	7,043	7,043
Sufficient Space Available on Parcel?	Yes	No	Yes	No	Yes	Yes	Yes

As noted in Chapter 3.2.1, the treated effluent from the WBA process is assumed to have a Chrome 6 concentration of 0.001 mg/L. The minimum treatment flow and bypass flows indicated in Table 4-7 represent the split of flows to allow the blended product water to meet the final treated water goal of 0.005 mg/L.

Comparing the estimated parcel space available against the conceptual system footprint yielded the following findings:

- The sites for Wells No. 2, 6, 8, 9, and 11 appear to have sufficient space available to accommodate a WBA treatment system at each location.
- The sites for Wells No. 5 and 7 do not appear to have sufficient space available.

4.3 Strong Base Anion Exchange (SBA)

The reference conceptual wellhead SBA treatment system used for this analysis consists of the primary system components and operating criteria as indicated in Table 4-8.

Table 4-8: Wellhead SBA System Components and Operating Criteria

Parameter	Unit	Value	Note
Treatment Flow	gpm	1,000	
Primary System Components			
Cartridge Filter Vessel			See (a)
No. of Units	-----	1	
Cartridge Filter Elements per Vessel	No.	52	
Element Diameter	inch	2.5	
Element Length	inch	40.0	
SBA System			See (a)
No. of Treatment Trains	-----	1	
No. of Vessels per Train	-----	1	
Vessel Diameter	feet	10	
Resin Volume per Vessel	Cu. Ft.	424	
Resin Regeneration System			See (b)
Brine Saturator	gal	1 x 7,500	
Brine Recirculation Tank	gal	1 x 3,000	
Salt Storage Tank	gal	1 x 2,000	2 week storage
Product Water Tank	gal	1 x 858,000	12 hr min. storage
Primary Operating Parameters			
Cartridge Filter Replacement Interval			
Run Time between Regenerations	hour	10.8	
Salt Consumption per Regeneration	lbs	3,700	
Brine Volume per Regeneration	gal	6,150	
Resin Change Out Frequency	year	7	

Footnotes:

a. Evoqua, 2016.
b. WesTech, 2016.

Table 4-9 presents the estimated space requirements for the reference SBA treatment system presented in Table 4-8.

Table 4-9: Estimates of SBA Space Requirement for 1,000 gpm Reference System

Parameter	Footprint (SF)
Cartride Filter Vessel	50
SBA System	297
Brine Saturator	196
Brine Recirculation Tank	100
Salt Storage Tank	144
Product Water Tank	6,724
Subtotal Major Equipment	*7,511*
Scale Up Factor[a]	6.81
System Space Requirement	51,159

Footnotes:

a. Based on Santa Clara Valley Water District Site 2 Advanced Water Purification Facility.

The reference footprint was scaled up or down in increments of 50% to estimate the space requirement for a system to accommodate the treatment flow rate at each wellhead site. Table 4-9 presents a summary of the flow rates for each well site and compares the space available versus the conceptual treatment system space requirements.

Table 4-10: Wellhead SBA System Treatment Flows and Footprint Evaluation

Item	Well No.						
	2	5	6	7	8	9	11
Flow Rates (gpm)							
Well Capacity	800	1,400	600	1,500	1,000	800	1,200
Minimum Treatment Flow	599	1,036	468	1,314	761	596	866
Bypass	201	364	132	186	239	204	334
System Design Treatment Flow	1,000	1,500	500	1,500	1,000	1,000	1,000
Total Parcel Size (SF)	15,766	2,200	16,792	9,583	60,113	40,190	58,806
Estimated Available Space on Parcel (SF)	**14,875**	**1,614**	**16,292**	**7,465**	**51,644**	**38,110**	**56,756**
Minimum System Footprint (SF)	51,159	76,739	25,580	76,739	51,159	51,159	51,159
Sufficient Space Available on Parcel?	No	No	No	No	Marginal	No	Yes

As noted in Chapter 3.3.1, the treated effluent from the SBA process is assumed to have a Chrome 6 concentration of 0.001 mg/L. The minimum treatment flow and bypass flows indicated in Table 4-10 represent the split of flows to allow the blended product water to meet the final treated water goal of 0.005 mg/L.

Comparing the estimated parcel space available against the conceptual system footprint yielded the following findings:

- The site for Well No. 11 appears to have sufficient space available to accommodate an SBA treatment system at each location.
- The site for Well No. 8 is considered marginal because the conceptual footprint requirement for the treatment system is close to the estimated space available at the location.

- The sites for Well Nos. 2, 5, 6, 7, and 9 do not appear to have sufficient space available.

These space issues are driven primarily by the need for the large product water tank, which is sized to mitigate the nitrate dumping that occurs with the SBA resin.

Spent Brine Management

The 1,000 gpm reference system is anticipated to generate approximately 13,700 gallons per day of spent brine. Therefore, operating at treatment capacity, the 7 current potable wells would generate a total of approximately 96,000 gallons per day of spent brine. Sewer disposal is the preferred option. However, as noted in Chapter 3.3.2., liquid waste hauling to EBMUD and evaporation ponds are potential disposal options if discharge to sewer is not allowable. Costs for liquid hauling for SBA spent brine are presented in Chapter 6. The conceptual acreage required to accommodate the spend brine is as follows:

- For treatment for the initial 7 potable wells in the system, a minimum of 9.5 acres is estimated to be required.
- For this well head treatment capacity at 2050, a minimum of 17 acres is estimated to be required.

4.4 Reverse Osmosis (RO)

The reference conceptual wellhead RO treatment system used for this analysis consists of the primary system components and operating criteria as indicated in Table 4-11.

Table 4-11: Wellhead RO System Components and Operating Criteria

Parameter	Unit	Value	Note
System Feed Flow	gpm	1,000	
Primary System Components			
Membrane Filter			See (a)
Type	-----	UF	
No. of Trains	-----	2	
Modules per Train	-----	24	
Total Modules	-----	48	
Spent Backflush Tank	gal	1 x 50,000	12 hr storage
Lamella Plate Settler			See (b)
No. of Units	-----	1	
Feed Flow Rate (each)	gpm	50	
Cartridge Filter			See (c)
No. of Units	-----	1	
Cartridge Filter Elements per Unit	No.	103	
Element Diameter	inch	2.5	
Element Length	inch	30.0	
Antiscalant Tank	gal	1 x 150	
Interprocess Tank	gal	1 x 35,000	
RO System			See (a)
No. of Trains	-----	1	
Stage per Train	-----	2	
1st Stage Pressure Vessels	-----	16	
2nd Stage Pressure Vessels	-----	8	
Total No. of Pressure Vessels	-----	24	
RO Elements per Vessel	-----	7	
Total No. of RO Elements	-----	168	
Sodium Hydroxide Tank	gal	1 x 1,200	
Product Water Tank	gal	1 x 5,000	

Table 4-11: Wellhead RO System Components and Operating Criteria (cont.)

Parameter	Unit	Value	Note
Primary Operating Parameters			
UF Backflush			See (a)
No. per day per UF Train	-----	48	
Total per day	-----	96	
Volume per Backflush	gal	1,000	
UF Maintenance Clean Frequency	-----	1 month	
UF CIP Frequency	-----	6 months	
Cartridge Filter Replacement Interval	-----	2 weeks	
RO System			
Recovery (average)	-----	82%	
Permeate Flow	gpm	820	
Brine	gpm	180	
RO CIP Frequency	-----	1 per 6 months	
Chemical Dosing			
Antiscalant	ppm	3	
Sodium Hydroxide	mg/L	20	

Footnotes:

a. Evoqua, 2016.
b. WesTech , 2016.
c. Parker, 2016.

Table 4-12 presents the estimated space requirements for the reference RO treatment system outlined in Table 4-11.

Table 4-12: Estimates of RO Space Requirement for 1,000 gpm Reference System

Parameter	Footprint (SF)
Membrane Filter (UF)	193
Spent Backflush Tank	729
Lamella Plate Settler	70
Interprocess Tank	484
Cartridge Filter	50
Antiscalant Tank	25
RO System	297
Sodium Hydroxide Tank	64
Product Water Tank	144
Subtotal Major Equipment	*2,056*
Scale Up Factor[a]	6.81
System Space Requirement	14,004

Footnotes:

a. Based on Santa Clara Valley Water District Site 2 Advanced Water Purification Facility.

The reference footprint was scaled up or down in increments of 50% to estimate the space requirement for a system to accommodate the treatment flow rate at each wellhead site. Table 4-13 presents a summary of the flow rates for each well site and compares the space available versus the conceptual treatment system space requirements.

Table 4-13: Wellhead RO System Treatment Flows and Footprint Evaluation

Item	Well No.						
	2	5	6	7	8	9	11
Flow Rates (gpm)							
Well Capacity	800	1,400	600	1,500	1,000	800	1,200
Permeate	576	1,003	441	1,162	727	575	850
Brine	127	220	97	255	159	126	186
Bypass	97	177	62	83	114	99	164
Product Water to System	673	1,180	503	1,245	841	674	1,014
System Design Treatment Flow	1,000	1,500	500	1,500	1,000	1,000	1,000
Total Parcel Size (SF)	15,766	2,200	16,792	9,583	60,113	40,190	58,806
Estimated Available Space on Parcel (SF)	**14,875**	**1,614**	**16,292**	**7,465**	**51,644**	**38,110**	**56,756**
Minimum System Footprint (SF)	14,004	21,006	7,002	21,006	14,004	14,004	14,004
Sufficient Space Available on Parcel?	Marginal	No	Yes	No	Yes	Yes	Yes

As noted in Chapter 3.4.1, the treated effluent from the RO process is assumed to have a Chrome 6 concentration of 0.003 mg/L. The permeate and bypass flows indicated in Table 4-13 represent the split to allow the blended product water to meet the final treated water goal of 0.005 mg/L.

Comparing the estimated parcel space available against the conceptual system footprint yielded the following findings:

- The sites for Wells No. 6, 8, 9, and 11 appear to have sufficient space available to accommodate an RO treatment system at each location.
- The Well No. 2 site appears to have sufficient space, but is considered marginal because the conceptual system footprint requirement is close to the estimated space available at that location.
- The sites for Wells No. 5 and 7 do not appear to have sufficient space available.

Spent Brine Management

The 1,000 gpm reference system is anticipated to generate approximately 180 gpm of RO brine. Therefore, operating at treatment capacity, the 7 current potable wells would generate a total of approximately 1,260 gpm of RO brine. Sewer disposal of the brine is the preferred option. However, as noted in Chapter 3.4.2., the use of evaporation ponds is a potential disposal option if discharge to sewer is not permitted. The conceptual acreage required to accommodate the spend brine is as follows:

- For treatment for the initial 7 potable wells in the system, a minimum of 170 acres is estimated to be required.
- For this well head treatment capacity at 2050, a minimum of 345 acres is estimated to be required.

Chapter 5 Centralized Facility Analysis

Using this information and the base design criteria described in Chapter 3 for each technology, this chapter presents conceptual system requirements and layout for each of the treatment technologies as well as the raw water, treated water, and residuals disposal pipelines needed for a centralized system. Please note the following common elements have been applied to all of the centralized alternatives:

- The parcel described earlier in Chapter 3.5 was identified by the City as the location for potential centralized Chrome 6 treatment facility.
- As discussed in Chapter 2.1, the peak day potable water demand projections for the years 2030 (8,550 gpm) and 2050 (13,400 gpm) were used to establish the initial and ultimate centralized facility product water capacities, respectively. The footprint for the facility, conveyance infrastructure (i.e., raw water, product water, residuals disposal, and yard piping), and space allocation for equipment were sized for 2050. The initial equipment installed for treatment was sized for 2030. Initial and future equipment are shown in the centralized facility layouts.
- Tanks for bulk chemicals were sized to provide 30 days of storage, unless otherwise noted.
- Access is assumed from Locust Ave. to the east.
- All centralized facilities include a process building. Housed within this building are the following:
    a. Membrane skids, as applicable (i.e., UF and/or RO trains).
    b. Staff facilities area. This would include locker facilities, restrooms, and a breakroom.
    c. Storage and sprinkler room.
    d. Support equipment room.
    e. Electrical and control rooms.
- All other equipment components are outdoors, unless otherwise noted.

5.1 Reduction-Coagulation-Filtration (RCF)

Table 5-1 presents the conceptual system requirements and basis for a centralized RCF treatment system.

Table 5-1: Conceptual System Requirements for Centralized RCF Treatment

Parameter	Unit	2030 Value	2050 Value	Note
Projected Potable Demand				
Average Annual (Master Plan)	AFY	7,660	12,000	
Average Annual	gpm	4,750	7,440	
Peak Day	gpm	8,550	13,400	
System Flow Rates				
Total Treated Effluent Capacity	gpm	7,620	11,940	
Bypass for Blending	gpm	930	1,460	
Total Product Water Capacity	gpm	8,550	13,400	
Primary System Components				
Influent Water Tank	gal	1 x 70,000	1 x 70,000	
Process Pumps to Treament				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	40	40	
Bypass Pumps to Blending				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	25	25	
Reduction/Coagulation Process				See (a)
Reduction/Coagulation Train				
Reduction Tanks (per train)	gal	1 x 5,000	1 x 5,000	
Coagulations Tank (per train)	gal	1 x 5,000	1 x 5,000	
Total No. of Trains	-----	8	13	
Ferrous Sulfate Tank	gal	1 x 10,500	1 x 10,500	
Sodium Hypochlorite Storage	gal	1 x 6,500	1 x 6,500	
Polymer Tank	gal	1 x 800	1 x 800	Day Tank
UF Pumps				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	140	140	
Membrane Filter				See (b)
Type	-----	UF	UF	
No. of Trains	-----	5	7	
Modules per Train	-----	90	90	
Total Modules	-----	450	630	
Backflush Supply Tank	gal	1 x 25,000	1 x 25,000	
Spent Backflush Tank	gal	1 x 59,000	2 x 59,000	12 hr storage
CIP Tank	gal	2 x 5,000	2 x 5,000	
CIP Neutralization Tank	gal	1 x 5,000	1 x 5,000	
Lamella Plate Settler				See (c)
No. of Units	-----	3	3	
Feed Flow Rate (each)	gpm	300	300	
Product Water Tank	gal	1 x 810,000	1 x 810,000	1 hr storage at 2050
Product Water Pumps				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	175	175	
Solids Management (if no sewer option)				
Sludge Storage Tank	gal	1 x 6,500	1 x 6,500	1 week min. storage at 2050
Screw Press	gpm	1 x 5.2	1 x 5.2	See (d)
Solids Bin	CY	1 x 25	3 x 25	See (e)

Table 5-1: Conceptual System Requirements for Centralized RCF Treatment (cont.)

Parameter	Unit	2030 Value	2050 Value	Note
Primary Operating Parameters				
Chemical Dosing				
Ferrous Sulfate	mg/L	2.7	2.7	See (f)
Sodium Hypochlorite	mg/L	1.1 - 1.5	1.1 - 1.5	See (f)
Polymer	mg/L	0.1	0.1	See (f)
UF Backflush Volume	gal/day	117,400	248,400	See (b)
UF Maintenance Clean Frequency	per train	1/week	1/week	See (b)
UF CIP Frequency	per train	1/month	1/month	See (b)
Screw Press Operation	hrs per week	15.6	33.0	See (d)

Footnotes:

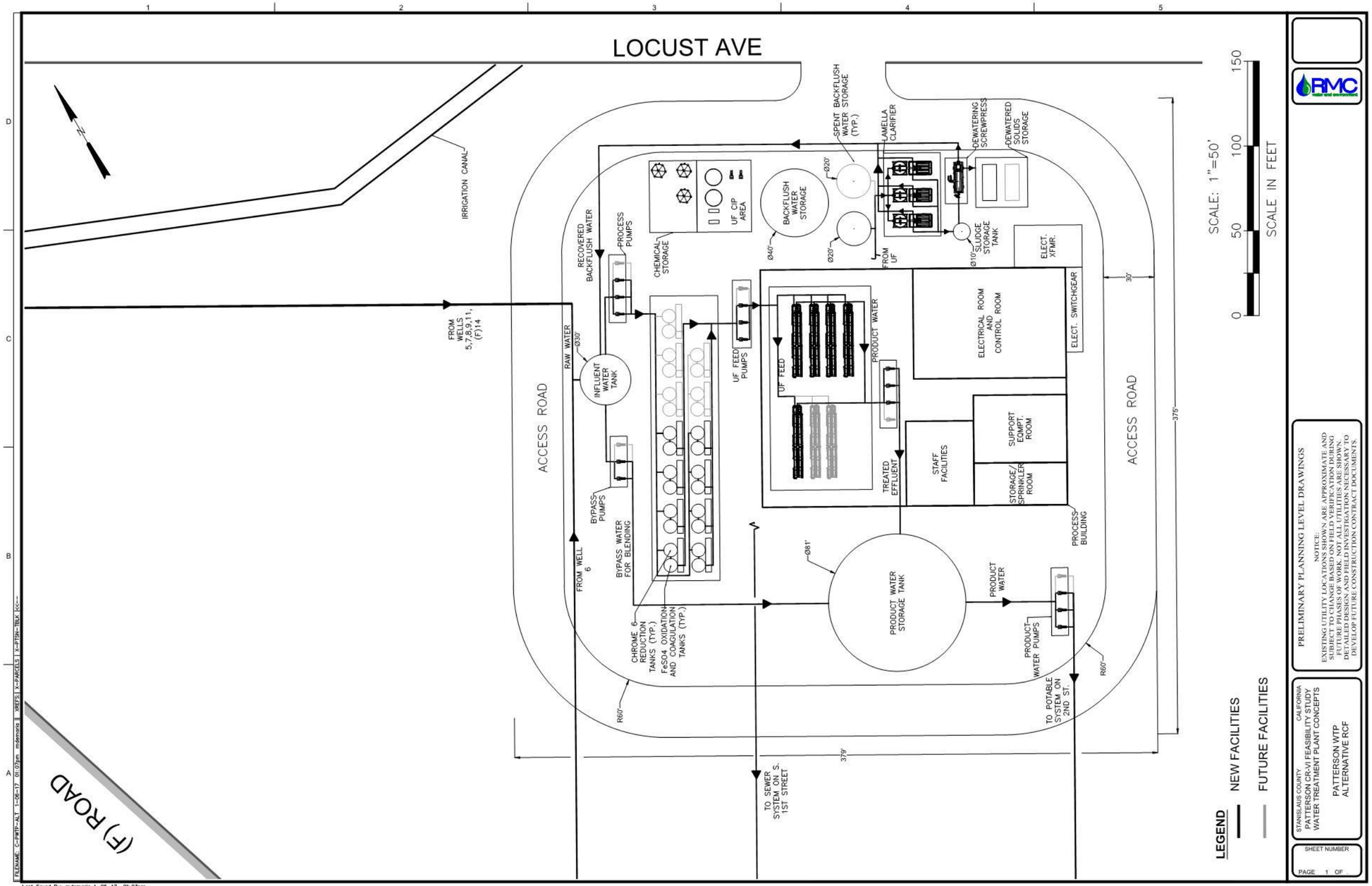
a. Evoqua, 2016.
b. WesTech, 2016, Versafilter units.
c. Parkson, 2016.
d. FKC, 2016.
e. Baker 2016, 25 CY roll off bin.
f. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.

A conceptual facility layout for the centralized RCF treatment system is presented in Figure 5-1. The following describes the operation of this treatment system and related facility components.

Treatment

- Water from the potable wells is conveyed to the influent of the Chrome 6 treatment facility where it is discharged to the influent water tank. The purpose of this tank in the process is to provide a stable basis for flow and pressure as the water is pumped to the influent of the RCF treatment process.
- The process pumps convey water from the influent water tank through the reduction and coagulation/oxidation tanks. 2 duty pumps and 1 standby pump are part of the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- The bypass pumps convey a second separate stream from the influent tank that bypasses the treatment process. This stream is blended in the product water tank with the effluent from the treatment process to meet the 0.005 mg/L product water goal. The bypass pumps are low pressure pumps and consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- For the reduction/coagulation portion of the RCF process, the water from the influent water tank is sent through by 8 treatment trains at the initial system capacity. Each train consists of two tanks in series – the first is a 5,000 gallon reduction tank where ferrous sulfate is added to the system; this is followed by a 5,000 gallon coagulation/reduction tank where sodium hypochlorite and polymer are added. This mechanics of this process were previously described in Chapter 3.1. At expansion to the 2050 capacity, the number of reduction/coagulation trains will increase from 8 to a total of 13.

Figure 5-1: Conceptual Site Layout for Centralized RCF Treatment Facility



- From the reduction/coagulation tanks, the UF feed pumps pump the water and solids through the filtration portion of the RCF process. These pumps provide the pressure boost needed for filtration. They consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump
- The filtration portion of the RCF process consists of 5 UF trains at the initial system capacity. At expansion to the 2050 capacity, the number of UF trains will increase from 5 to a total of 7. Treated effluent from the UF is conveyed to the product water tank
- The product water tank blends the bypass water with treated effluent from the RCF process to meet the 0.005 mg/L product water goal. Sodium hypochlorite is added to provide the chlorine residual needed prior to introduction to the potable water system. The tank is sized to provide 60 minutes of detention time at the 2050 facility capacity and is intended to act as a buffer between the treatment facility and the potable water system.
- The product water pumps convey the product water to the potable water system and are sized to provide a discharge pressure of 50 psi. 2 duty pumps and 1 standby pump are part of the initial system size to meet this requirement. At expansion to the 2050 capacity, the number of pumps will increase to a total of 3 duty pumps and 1 standby pump.

Residuals

- Spent backflush from the UF system is collected in the spent backflush tank. This tank is sized to provide 12 hours of storage at the 2050 treatment capacity.
- The spent backflush is metered through 3 lamella plate settlers to concentrate the blackflush solids to a 3% by weight solution. The supernatant water is returned to the UF feed. The 3% solids solution is discharged to sewer, if allowable.
- If sewer discharge is not allowable, the 3% solids solution is handled as follows:
    a. The 3% solution is discharged to a sludge storage tank which is sized to provide 1 week of storage at the 2050 treatment capacity.
    b. When sufficient volume is stored in the sludge storage tank, the 3% solution is fed through a screw press for dewatering. It is assumed that the screw press can achieve a 20% solids by weight cake for disposal as a solid waste.
    c. The dewatered solids are discharged to a roll off bin for onsite storage. When full, the bin contents are trucked offsite for landfill disposal.

Chemical Storage

The ferrous sulfate, sodium hypochlorite, and polymer are stored in a separate chemical building as shown on the facility layout. The chemical building is located along the northerly portion of the facility immediately adjacent to the access road to facilitate bulk chemical deliveries.

5.2 Weak Base Anion Exchange (WBA)

Table 5-2 presents the conceptual system requirements and basis for a centralized WBA treatment system.

Table 5-2: Conceptual System Requirements for Centralized WBA Treatment

Parameter	Unit	2030 Value	2050 Value	Note
Projected Potable Demand				
Average Annual (Master Plan)	AFY	7,660	12,000	
Average Annual	gpm	4,750	7,440	
Peak Day	gpm	8,550	13,400	
System Flow Rates				
Total Treated Effluent Capacity	gpm	6,870	10,770	
Bypass for Blending	gpm	1,680	2,630	
Total Product Water Capacity	gpm	8,550	13,400	
Primary System Components				
Influent Water Tank	gal	1 x 70,000	1 x 70,000	
Process Pumps to Treament				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	40	40	
Bypass Pumps to Blending				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	25	25	
Carbon Dioxide Storage				See (a)
No. of Storage Tanks	-----	2	3	
Capacity (each)	ton	91	91	
Total Storage	ton	182	273	
Tank Configuration	-----	Horizontal	Horizontal	
Diameter x Length	feet	10 x 55.5	10 x 55.5	
Cartridge Filter Vessel				See (b)
No. of Units	-----	2	4	
Cartridge Filter Elements per Vessel	No.	176	176	
Total No. of Elements	No.	352	704	
Element Diameter	inch	2.5	2.5	
Element Length	inch	40	40	
WBA System				See (c)
No. of Treatment Trains	-----	7	11	
No. of Vessels per Train	-----	2	2	
Operating Configuration	-----	Lead/Lag	Lead/Lag	
Vessel Diameter	feet	10	10	
Resin Volume per Vessel	cubic feet	424	424	
Decarbonator				See (d)
No. of Units	-----	2	4	
Length x Width X Height	ft	12 x 12 x 10	12 x 12 x 10	
Treated Water Tank	gal	1 x 810,000	1 x 810,000	1 hr storage at 2050
Product Water Pumps				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	175	175	
Primary Operating Parameters				
Resin Change Out Frequency	year	1.8	1.8	See (c)
Cartridge Filter Replacement Interval	-----	weekly	weekly	
Carbon Dioxide Feed Rate	lbs/day	10,990	17,230	See (a)

Footnotes:

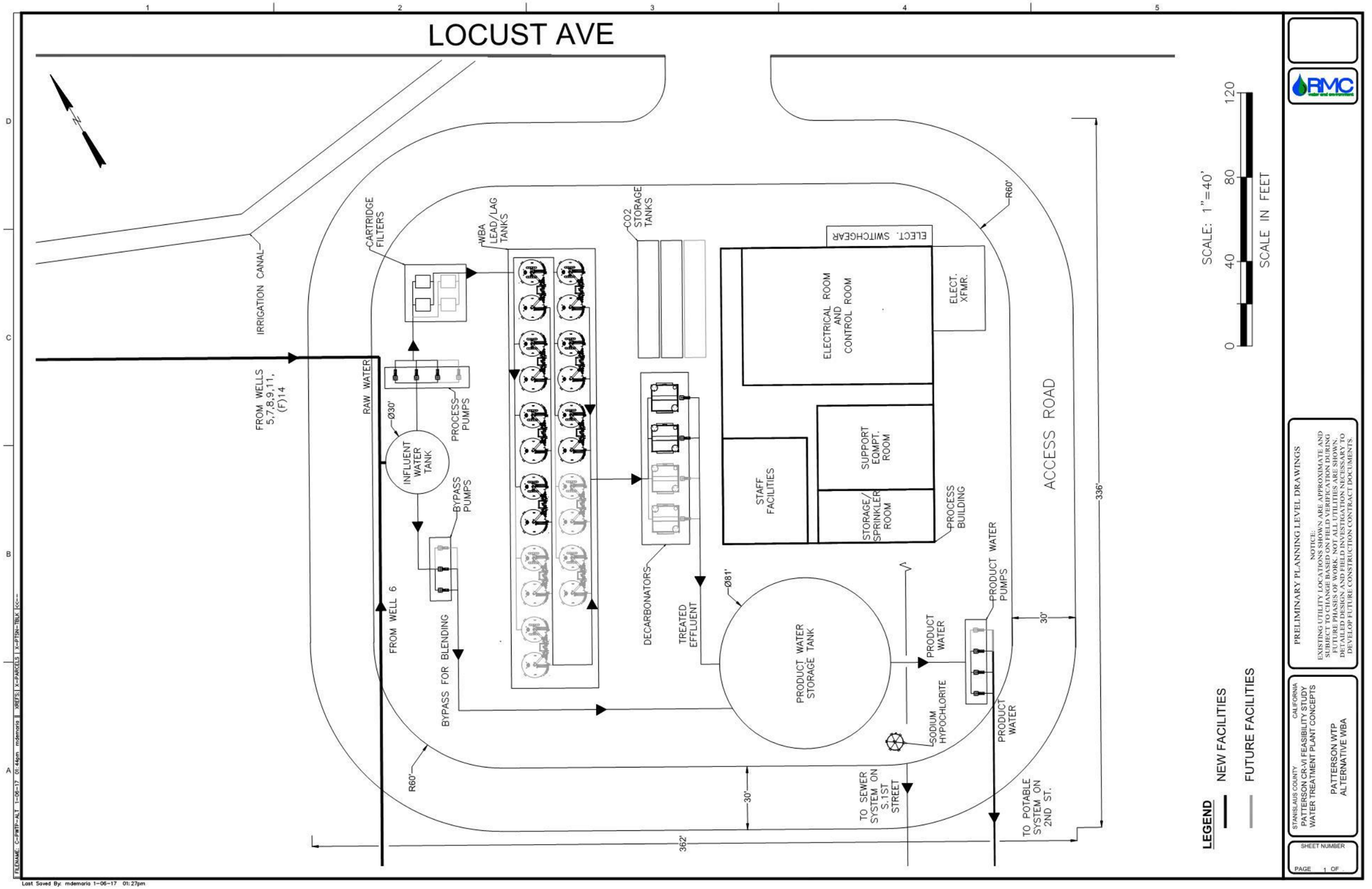
a. Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015
b. Parker, 2016.
c. Evoqua, 2016, HP1020 duplex units.
d. WesTech, 2016, aluminum induced air aerator

A conceptual facility layout for the centralized WBA treatment system is presented in Figure 5-2. The following describes the operation of this treatment system and related facility components.

Treatment

- Water from the potable wells is conveyed to the influent of the Chrome 6 treatment facility where it is discharged to the influent water tank. The purpose of this tank in the process is to provide a stable basis for flow and pressure as the water is pumped to the influent of the WBA treatment process.
- The process pumps convey water from the influent water tank through the WBA treatment trains. 2 duty pumps and 1 standby pump are part of the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- The bypass pumps convey a second separate stream from the influent tank that bypasses the treatment process. This stream is blended in the product water tank with the effluent from the treatment process to meet the 0.005 mg/L product water goal. The bypass pumps are low pressure pumps and consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- Water pumped from the influent water tank is adjusted to a pH of 6 by injecting carbon dioxide.
- Following the pH adjustment, the water is sent through by 7 WBA treatment trains at the initial system capacity. As described earlier, each train consists of two resin vessels configured in series for lead/lag operation. At expansion to the 2050 capacity, the number of WBA trains will increase from 7 to a total of 11.
- The treated effluent form the WBA trains is sent through a decarbonator system to restore the water pH near its initial level. The decarbonation process was described earlier in Chapter 3.2.1. 2 decarbonator towers are part of the initial system size. At expansion to the 2050 capacity, the number of decarbonator towers will be increased to a total of 4 units. The decarbonated water is pumped to the product water tank.
- The product water tank blends the bypass water with treated effluent from the WBA process to meet the 0.005 mg/L product water goal. Sodium hypochlorite is added to provide the chlorine residual needed prior to introduction to the potable water system. The tank is sized to provide 60 minutes of detention time at the 2050 facility capacity and is intended to act as a buffer between the treatment facility and the potable water system.
- The product water pumps convey the product water to the potable water system and are sized to provide a discharge pressure of 50 psi. 2 duty pumps and 1 standby pump are part of the initial system size to meet this requirement. At expansion to the 2050 capacity, the number of pumps will increase to a total of 3 duty pumps and 1 standby pump.

Figure 5-2: Conceptual Site Layout for Centralized WBA Treatment Facility



Residuals

Spent cartridge filters are the only regularly generated residual for disposal from this process. The change out frequency will depend on actual site conditions. For analysis purposes, it is assumed that the cartridge filter elements will be changed out once per week. As noted earlier in Chapter 3.2.2, the resin will eventually become exhausted and will require change outs at infrequent intervals. This is anticipated to occur approximately once every 1.8 years per vessel. The spent media is dewatered through gravity drainage of the excess water and addition of an adsorbent material, followed by hauling offsite to a hazardous waste landfill for disposal.

Chemical Storage

Carbon dioxide and sodium hypochlorite are the chemicals that requires bulk onsite storage. Carbon dioxide is stored as a liquid in tanks that are set outdoors and are located along the northerly portion of the facility immediately adjacent to the access road to facilitate bulk chemical deliveries. Two 91 ton storage tanks will be used at the initial facility capacity. At expansion to the 2050 capacity, the number of tanks will be increased to a total of three 91 ton tanks. One 9,300 gallon tank will be used to store bulk sodium hypochlorite (12.5% by weight) to provide approximately 30 days of storage at the 2050 treatment capacity.

5.3 Strong Base Anion Exchange (SBA)

Table 5-3 presents the conceptual system requirements and basis for a centralized SBA treatment system.

Table 5-3: Conceptual System Requirements for Centralized SBA Treatment

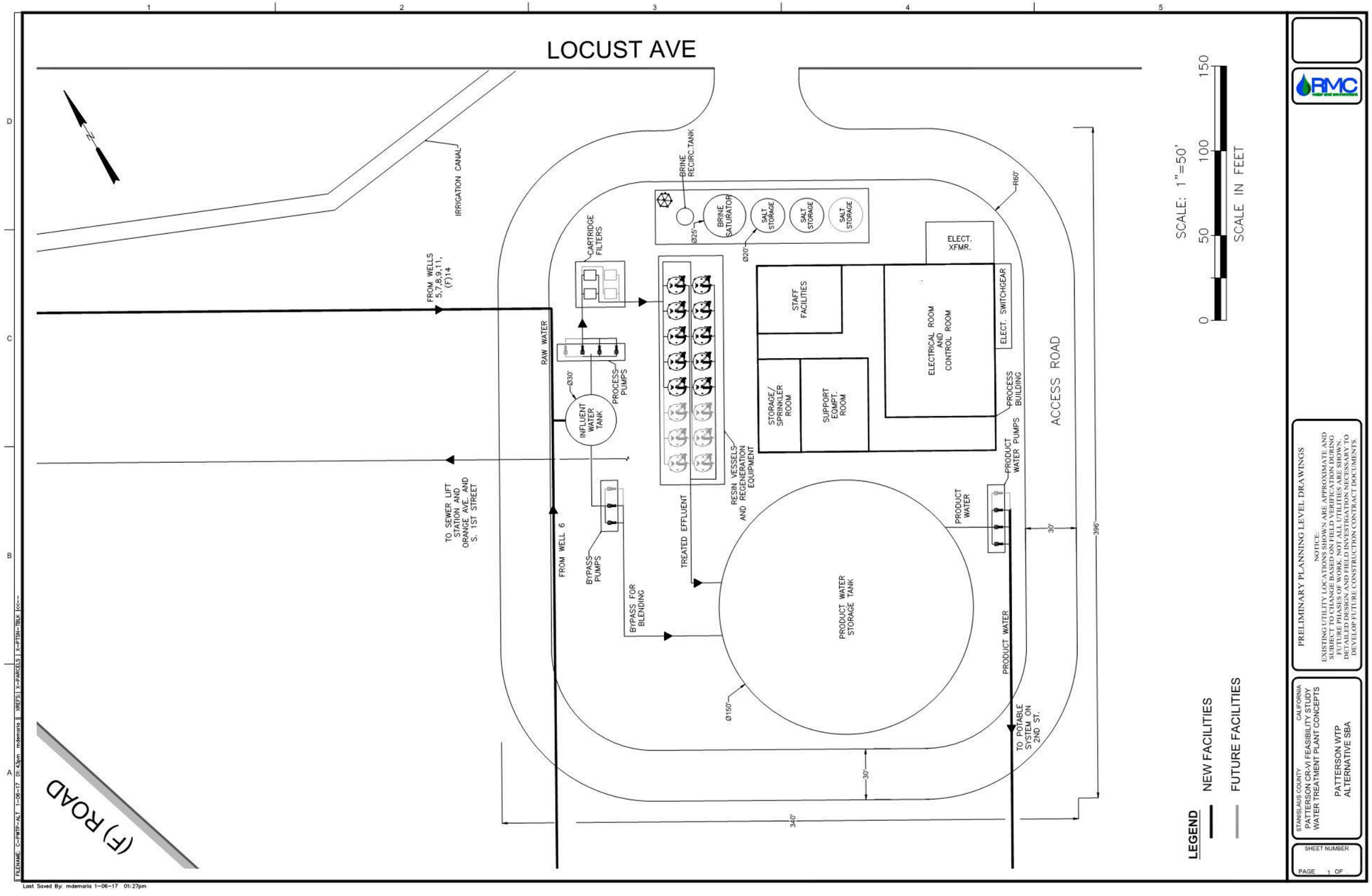
Parameter	Unit	2030 Value	2050 Value	Note
Projected Potable Demand				
Average Annual (Master Plan)	AFY	7,660	12,000	
Average Annual	gpm	4,750	7,440	
Peak Day	gpm	8,550	13,400	
System Flow Rates				
Total Treated Effluent Capacity	gpm	6,870	10,770	
Bypass for Blending	gpm	1,680	2,630	
Total Product Water Capacity	gpm	8,550	13,400	
Primary System Components				
Influent Water Tank	gal	1 x 70,000	1 x 70,000	
Process Pumps to Treament				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	40	40	
Bypass Pumps to Blending				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	25	25	
Cartride Filter Vessel				See (a)
No. of Units	-----	2	4	
Cartridge Filter Elements per Vessel	No.	176	176	
Total No. of Elements	No.	352	704	
Element Diameter	inch	2.5	2.5	
Element Length	inch	40	40	
SBA System				See (b)
No. of Treatment Trains	-----	10	16	
No. of Vessels per Train	-----	1	1	
Vessel Diameter	feet	10	10	
Resin Volume per Vessel	cubic feet	424	424	
Resin Regeneration System				
Brine Saturator	gal	1 x 50,000	1 x 50,000	
Brine Recirculation Tank	gal	1 x 6,000	1 x 6,000	
Salt Storage Tank	gal	2 x 70,500	3 x 70,500	
Product Water Tank	MG	1 x 5.7	1 x 5.7	10.8 hr min. storage at 2030
Primary Operating Parameters				
Cartridge Filter Replacement Interval	-----	weekly	weekly	
Run Time between Regenerations	hour	10.8	10.8	See (b)
Salt Consumption per Regeneration	lbs	3,700	3,700	See (b)
Brine Volume per Regeneration	gal	4,040	4,040	See (b)
Resin Change Out Frequency	year	7	7	See (b)

Footnotes:

a. Parker, 2016.
b. Wigen, 2016.

A conceptual facility layout for the centralized SBA treatment system is presented in Figure 5-3.

Figure 5-3: Conceptual Site Layout for Centralized SBA Treatment Facility



The following describes the operation of this treatment system and related facility components.

Treatment

- Water from the potable wells is conveyed to the influent of the Chrome 6 treatment facility where it is discharged to the influent water tank. The purpose of this tank in the process is to provide a stable basis for flow and pressure as the water is pumped to the influent of the SBA treatment process.
- The process pumps convey water from the influent water tank through the SBA treatment vessels. 2 duty pumps and 1 standby pump are part of the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- The bypass pumps convey a second separate stream from the influent tank that bypasses the treatment process. This stream is blended in the product water tank with the effluent from the treatment process to meet the 0.005 mg/L product water goal. The bypass pumps are low pressure pumps and consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- Water pumped from the influent water tank is adjusted to a pH of 6 by injecting carbon dioxide.
- Water pumped from the influent water tank is sent through by 10 SBA treatment vessels at the initial system capacity. At expansion to the 2050 capacity, the number of SBA vessels will increase from 10 to a total of 16. Treated effluent form the SBA vessels is conveyed to the product water tank.
- The product water tank blends the bypass water with treated effluent from the SBA process to meet the 0.005 mg/L product water goal. Sodium hypochlorite is added to provide the chlorine residual needed prior to introduction to the potable water system. The tank is sized to provide 10.8 hours of detention time at the 2030 facility capacity. As noted earlier, the product water tank for SBA is sized to capture one full treatment cycle of treatment between regenerations to minimize the impact of nitrate dumping by the SBA resin.
- The product water pumps convey the product water to the potable water system and are sized to provide a discharge pressure of 50 psi. 2 duty pumps and 1 standby pump are part of the initial system size to meet this requirement. At expansion to the 2050 capacity, the number of pumps will increase to a total of 3 duty pumps and 1 standby pump.

Regeneration

Regeneration of the SBA vessels is performed as per the process description in Chapter 3.3.1. Two 70,500 gallon bulk salt storage tanks are assumed for the SBA system for the initial treatment system capacity. For the expansion to the 2050 capacity, the number of bulk salt storage tanks will be increased from 2 to 3.

Residuals

Spent cartridge filter elements and spent brine regenerant are the residuals generated from this process that will require disposal on a regular basis. The change out frequency of spent cartridge filter elements will depend on actual site conditions. For analysis purposes, it is assumed that the cartridge filter elements will be changed out once per week. Spent brine regenerant will need to be disposed of on a daily, if not more frequent, basis. For the Feasibility Study, the following were considered as disposal options:

a. Sewer disposal. It is anticipated that up to 89,700 gallons per day of spent brine will be generated at the 2030 treatment capacity. At the 2050 capacity, the spent brine generation rate increases to

up to 143,500 gallons per day. As noted in Chapter 3.3.3, it is not clear if the Patterson WQCF can accept the volume and strength of brine generated from this treatment process.

b. Hauling of the spent brine by truck to (EBMUD) for disposal as a liquid waste. Costs for this disposal option are presented in Chapter 6.

c. Disposal to evaporation ponds. The conceptual acreage required to accommodate the spend brine is as follows:

    a. 9 acres of evaporation ponds accommodate the spent brine at the 2030 capacity.

    b. 14 acres of evaporation ponds accommodate the spent brine at the 2050 capacity

    These acreage requirements were estimated as an initial measure to assess feasibility of this disposal option. Due to unknowns as to location(s) for the ponds and required support infrastructure, costs were not developed for this disposal option.

Chemical Storage

The bulk salt storage, brine saturator, brine recirculation tank, and sodium hypochlorite storage tank are located along the northerly portion of the facility immediately adjacent to the access road to facilitate bulk salt and chemical deliveries.

5.4 Reverse Osmosis (RO)

Table 5-4 presents the conceptual system requirements and basis for a centralized WBA treatment system.

Table 5-4: Conceptual System Requirements for Centralized RO Treatment

Parameter	Unit	2030 Value	2050 Value	Note
Projected Potable Demand				
Average Annual (Master Plan)	AFY	7,660	12,000	
Average Annual	gpm	4,750	7,440	
Peak Day	gpm	8,550	13,400	
System Flow Rates				
Total Treated Effluent Capacity	gpm	7,620	11,940	
Bypass for Blending	gpm	930	1,460	
Total Product Water Capacity	gpm	8,550	13,400	
Primary System Components				
Influent Water Tank	gal	1 x 70,000	1 x 70,000	
UF Feed Pumps				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	40	40	
Bypass Pumps to Blending				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	25	25	
Membrane Filter				See (a)
Type	-----	UF	UF	
No. of Trains	-----	6	9	
Modules per Train	-----	90	90	
Total Modules	-----	540	810	
Interprocess Tank	gal	1 x 25,000	1 x 25,000	
Spent Backflush Tank	gal	1 x 59,000	2 x 59,000	12 hr storage
CIP Tank	gal	2 x 5,000	2 x 5,000	
CIP Neutralization Tank	gal	1 x 5,000	1 x 5,000	
Lamella Plate Settler				See (b)
No. of Units	-----	3	3	
Feed Flow Rate (each)	gpm	300	300	
Cartridge Filter Vessel				See (c)
No. of Units	-----	2	4	
Cartridge Filter Elements per Vessel	No.	176	176	
Total No. of Elements	No.	352	704	
Element Diameter	inch	3	3	
Element Length	inch	40	40	
Antiscalant Tank	gal	1 x 2,000	1 x 2,000	30 days storage at 2050
RO Booster Pumps				
No.	-----	4	7	
Motor HP (each)	HP	175	175	
RO System				See (d)
No. of Trains	-----	4	7	
Stage per Train	-----	2	2	
1st Stage Pressure Vessels	-----	36	36	
2nd Stage Pressure Vessels	-----	18	18	
Total No. of Pressure Vessels	-----	54	54	
RO Elements per Vessel	-----	7	7	
RO Elements per Train	-----	378	378	
Total No. RO Elements for System	-----	1,512	2,646	

Table 5-4: Conceptual System Requirements for Centralized RO Treatment (cont.)

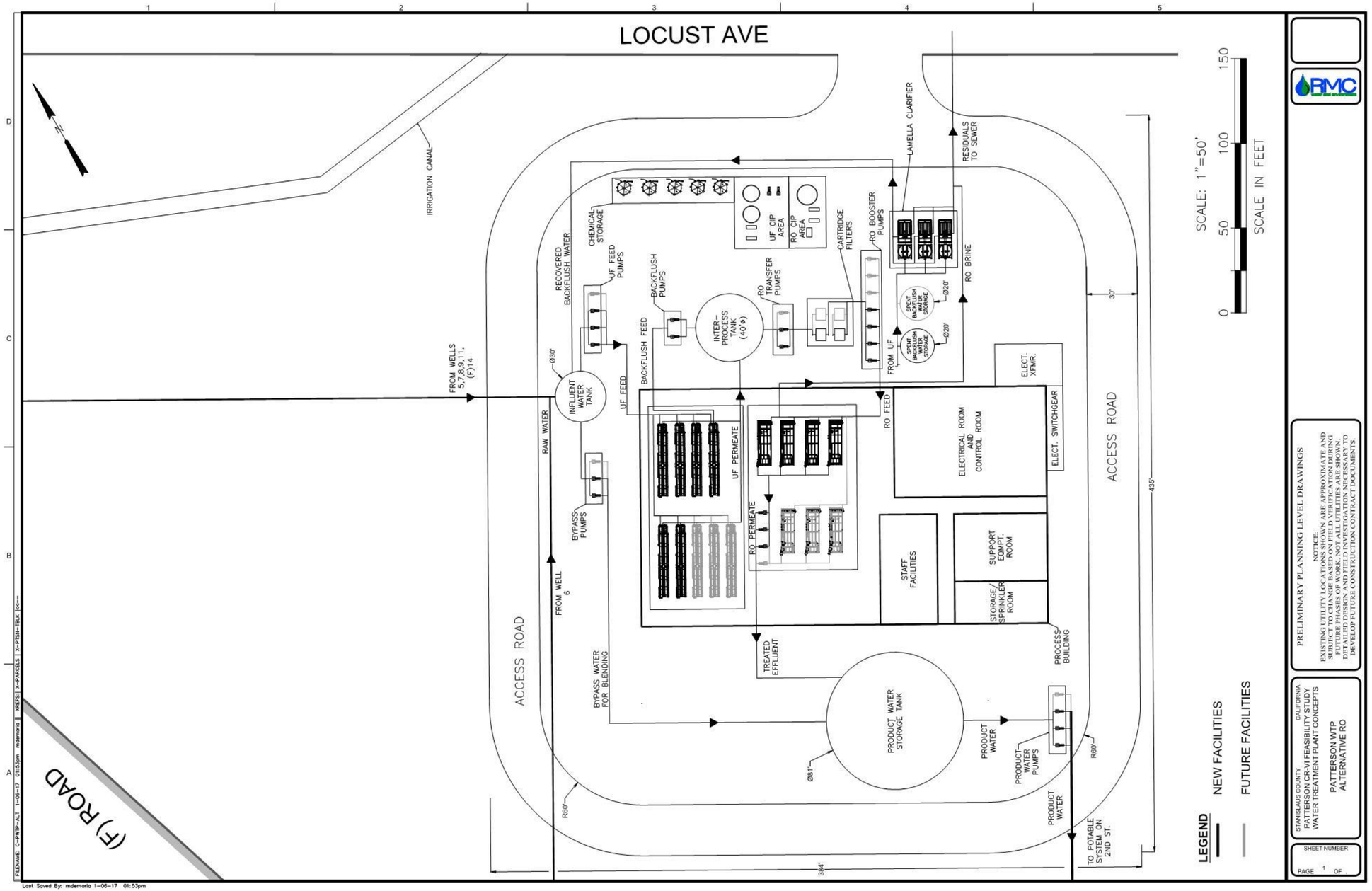
Parameter	Unit	2030 Value	2050 Value	Note
Sodium Hydroxide Tank	gal	1 x 15,500	1 x 15,500	30 days storage at 2050
Product Water Tank	gal	1 x 810,000	1 x 810,000	1 hr storage at 2050
Product Water Pumps				
Duty/Standby	No.	2/1	3/1	
Motor HP (each)	HP	175	175	
Product Water Tank	gal	1 x 810,000	1 x 810,000	1 hr storage at 2050
Primary Operating Parameters				
UF System				
Backflush Volume	gal/day	117,400	248,400	See (a)
Maintenance Clean Frequency	per train	1/week	1/week	See (a)
UF CIP Frequency	per train	1/month	1/month	See (a)
Cartridge Filter Replacement Interval	-----	2 weeks	2 weeks	
RO System				
Recovery (average)	-----	82%	82%	
Permeate Flow	gpm	7,620	11,940	
Brine	gpm	1,673	2,621	
RO CIP Frequency	-----	1 per 6 months	1 per 6 months	
Chemical Dosing				
Antiscalant	ppm	3	3	
Sodium Hydroxide	mg/L	2	2	

Footnotes:

a. WesTech, 2016, Versafilter units.
b. Parkson, 2016.
c. Parker, 2016.
d. Wigen, 2016.

A conceptual facility layout for the centralized RO treatment system is presented in Figure 5-4.

Figure 5-4: Conceptual Site Layout for Centralized RO Treatment Facility



The following describes the operation of this treatment system and related facility components.

Treatment

- Water from the potable wells is conveyed to the influent of the Chrome 6 treatment facility where it is discharged to the influent water tank. The purpose of this tank in the process is to provide a stable basis for flow and pressure as the water is pumped to the influent of the RO treatment process.
- The UF feed pumps pump the water from the influent water tank to the UF system. These pumps provide the pressure boost needed for filtration. They consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- The bypass pumps convey a second separate stream from the influent tank that bypasses the treatment process. This stream is blended in the product water tank with the effluent from the treatment process to meet the 0.005 mg/L product water goal. The bypass pumps are low pressure pumps and consist of 2 duty pumps and 1 standby pump at the initial system size. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump.
- From the UF feed pumps, water from the influent water tank is pumped through 6 UF trains at the initial treatment system capacity. At expansion to the 2050 capacity, the number of UF trains will increase from 6 to a total of 9. Treated effluent from the UF is conveyed to the interprocess tank.
- From the interprocess tank, water is pumped to the cartridge filters. At the initial facility capacity, the system will include 2 duty transfer pumps and 1 standby pump which will pump through 2 cartridge filter vessels. At expansion to the 2050 capacity, the number of pumps will be increased to a total of 3 duty pumps and 1 standby pump, and the number of cartridge filter vessels will increase from 2 to a total of 4.
- Antiscalant and sodium bisulfite (if required) are fed into the process stream.
- Water from the cartridge filter effluent is fed to the RO feed pumps. At the initial facility, the system will include 4 duty RO feed pumps. At the expansion to the 2050 capacity, the number of pumps will be increased from 4 to a total of 7.
- The RO feed pumps feed into 4 RO treatment trains at the initial system capacity. Each train contains two stages configured in a 2 x 1 array. At expansion to the 2050 capacity, the number of RO trains will increase from 4 to a total of 7. Permeate from the RO trains is conveyed to the product water tank. The brine generated from the RO trains is discharged to waste.
- Sodium hydroxide is fed to the permeate to mitigate the corrosivity of the water.
- The product water tank blends the bypass water with the RO permeate to meet the 0.005 mg/L product water goal. Sodium hypochlorite is added to provide the chlorine residual needed prior to introduction to the potable water system. The tank is sized to provide 60 minutes of detention time at the 2050 facility capacity and is intended to act as a buffer between the treatment facility and the potable water system.
- The product water pumps convey the product water to the potable water system and are sized to provide a discharge pressure of 50 psi. 2 duty pumps and 1 standby pump are part of the initial system size to meet this requirement. At expansion to the 2050 capacity, the number of pumps will increase to a total of 3 duty pumps and 1 standby pump.

Residuals

Spent cartridge filter elements, RO brine, spent backflush from the UF, and spent CIP from cleaning activities for the RO and UF are the residuals generated from this system. The means for disposal for each is described below.

Spent Cartridge Filter Elements

For analysis purposes, it is assumed that the cartridge filter elements will be changed out once per 2 week period. Unlike the WBA and SBA treatment systems, the use of cartridge filters for the RO treatment system is intended to be a secondary protective barrier. Therefore, the solids loading is anticipated to be considerably lower, resulting in a longer interval between change outs. Spent elements are anticipated to be a non-hazardous solid waste and are assumed to be disposed of in the trash.

Spent Backflush and Spent CIP Chemicals

These are assumed to be discharged to the sewer. The quantity of solids in the spent backflush is anticipated to be considerably lower than for the RCF process and should contain little or no chromium. Therefore, the spent backflush solids should not pose any issues for the Patterson WQCF.

RO Brine

RO brine will need to be disposed of on a continuous basis. For the Feasibility Study, the following were considered as disposal options:

1. Sewer disposal. It is anticipated that up to 1,673 gpm of RO brine will be generated at the 2030 treatment capacity with a TDS concentration up to 5,500 mg/L. At the 2050 capacity, the RO brine generation rate increases to up to 2,621 gpm. As noted in Chapter 3.4.3, it is not clear if the Patterson WQCF can accept the volume and strength of RO brine generated from this treatment process.
2. Disposal to evaporation ponds. Applying the methodology used to estimate the evaporation pond acreage for the centralized SBA system, the following minimum pond acreage is estimated to be required for RO brine disposal:
    a. 226 total acres of evaporation ponds to accommodate 1,673 gpm of RO brine at the 2030 capacity.
    b. 354 total acres of evaporation ponds to accommodate 2,621 gpm of RO brine at the 2050 capacity.

    These acreage requirements were estimated as an initial measure to assess feasibility of this disposal option. Due to unknowns as to location(s) for the ponds and required support infrastructure, costs were not developed for this disposal option

Hauling offsite as liquid waste was not considered as a feasible alternative, given the large volume of RO brine for disposal.

Chemical Storage

A chemical building housing the storage tanks for antiscalant, sodium hydroxide, and sodium hypochlorite is located along the northerly portion of the facility immediately adjacent to the access road to facilitate bulk chemical deliveries.

5.5 Centralized System Conveyance Piping

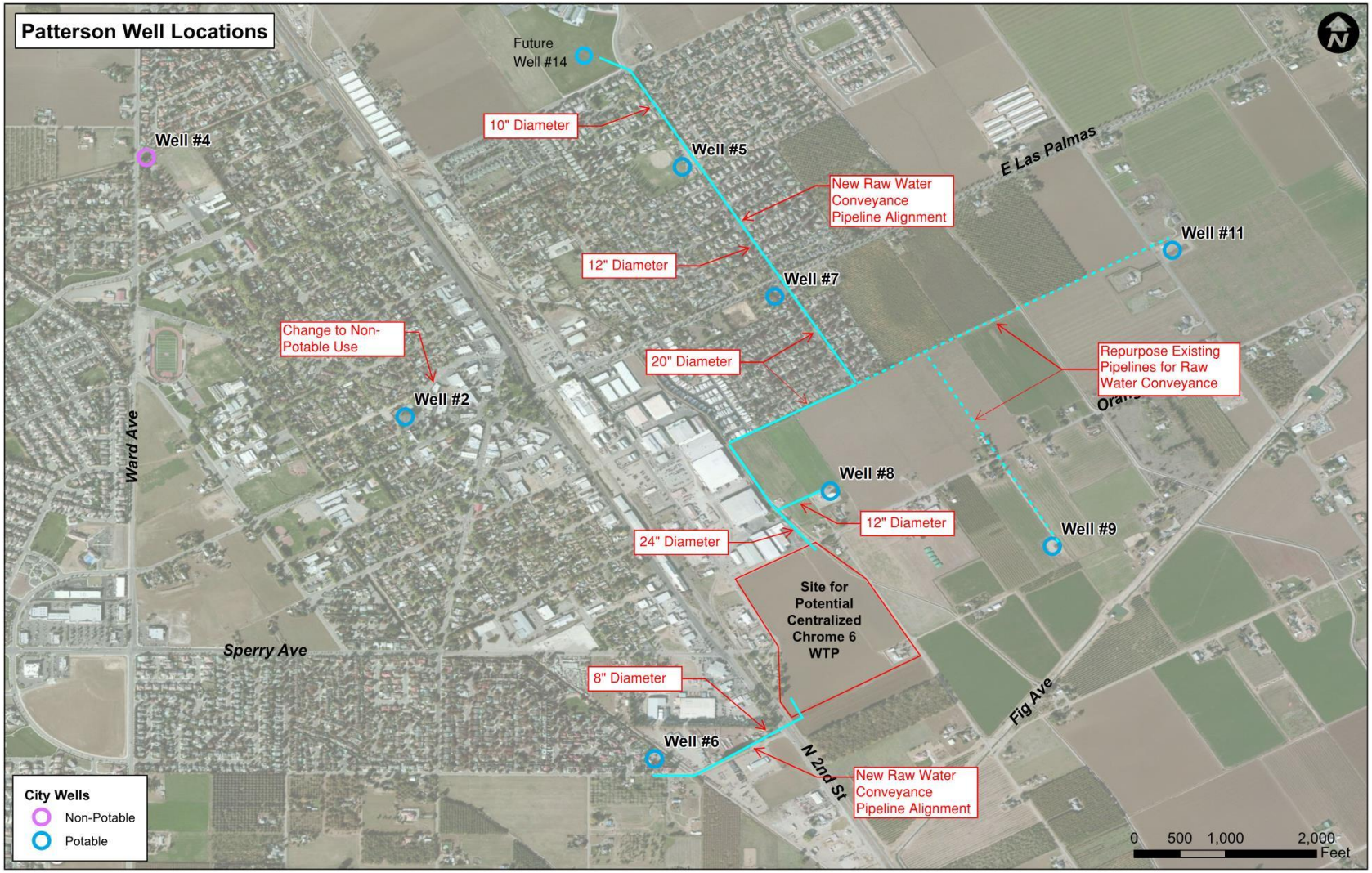
Each centralized treatment option will require conveyance piping to collect the raw water from the well sites to the treatment facility, a product water pipeline to convey the water from the product water tank to the potable distribution system, and a residuals disposal pipeline connected to the existing sewer system. These are described below.

Raw Water Conveyance Pipelines

Based on discussions with City staff, the alignment for the raw water conveyance pipeline shown in Figure 5-5 was assumed for the Feasibility Study. As noted in Chapter 2.1, Well No. 2 would be replaced by future Well No. 14 in accordance with discussions with City staff for the centralized treatment facility alternatives. A description of the raw water conveyance pipelines is as follows:

Two new raw water pipelines would be installed to convey water from the potable wells to the centralized treatment facility location. The first new conveyance pipeline would be constructed from the north starting at the Well No. 14 site and travel southerly along North Hartley Street to its intersection with East Las Palmas Ave. This segment of the raw water pipeline would capture Wells No. 5, 7, and 14. At this point, the alignment would turn westerly along East Las Palmas Ave. until it crosses the irrigation canal just west of Weber Ave. At this point, the alignment would turn southerly, following the alignment of the irrigation canal until its intersection with Orange Ave. This segment of raw water pipeline would capture Well No. 8. The alignment would then cross onto the centralized Chrome 6 treatment facility from the north end of the facility parcel. In addition to the new pipeline from the north, the existing pipelines east of North Hartley Street along East Las Palmas Ave would be disconnected from the potable distribution system and connected to the new raw water pipeline at the intersection of North Hartley Street and East Las Palmas Ave. These existing pipelines would be repurposed for raw water conveyance only and would capture Wells No. 9 and 11. The second new raw water pipeline would convey water from Well No. 6 to the westerly side of the treatment facility site, where it would cross onto the parcel and connect with the raw water conveyance pipeline from the north. This pipeline would initially travel easterly along Poppy Ave. to its intersection with South 2nd Street. At this point, the pipeline would turn northerly along South 2nd Street until its intersection with South 1st Street. The alignment would follow easterly along South 1st Street where it would cross the westerly boundary of the treatment facility parcel.

Figure 5-5: Conceptual Raw Water Pipeline Alignment



Product Water Pipeline

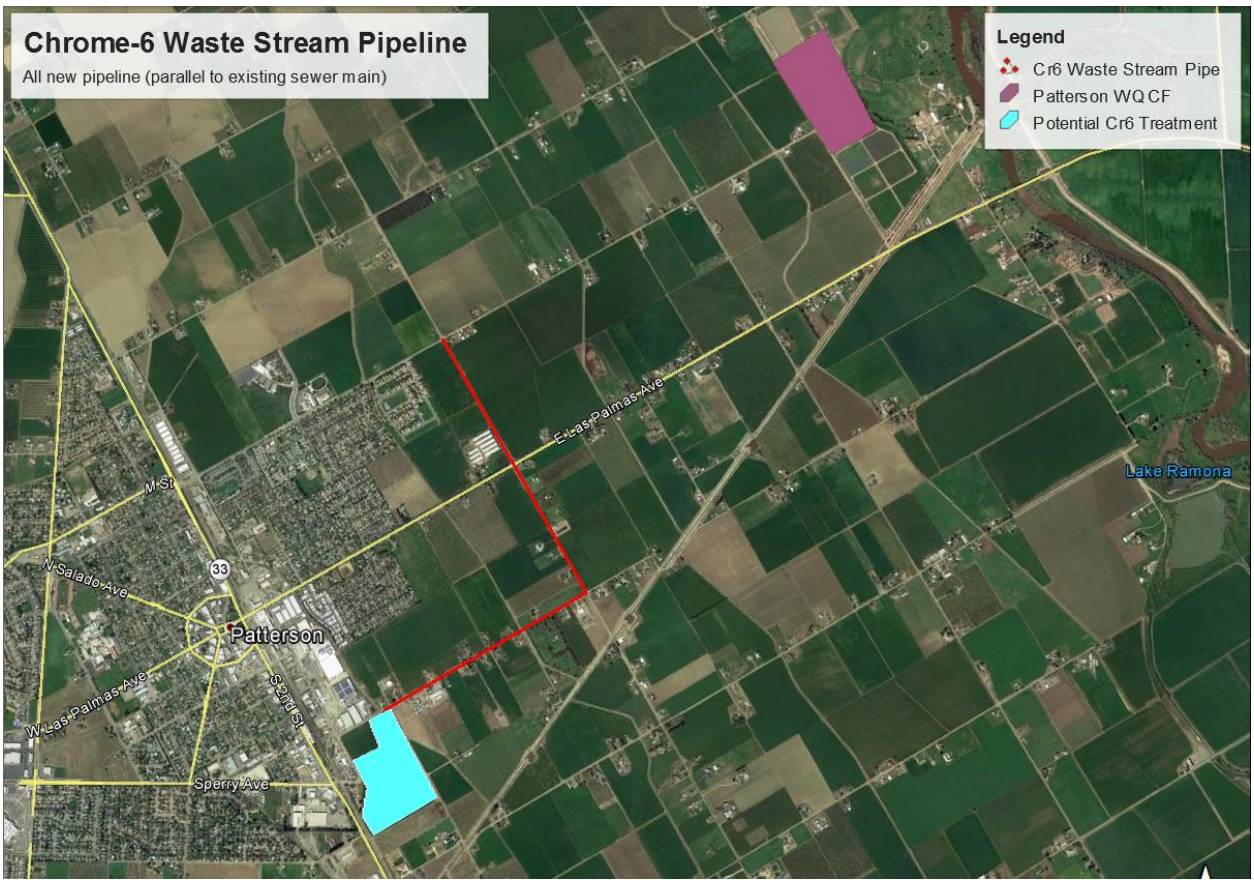
A 30-inch diameter pipeline would connect from the product water pumps at the product water tank to the existing 24-inch diameter water main on Second Street. Connecting to the 24-inch water main with a 30-inch pipeline is not anticipated to create a hydraulic restriction, as the water is expected to flow through both the north and south branches of the 24-inch water main at the connection location.

Residual Disposal

Residual disposal to the sewer system will depend on the volume of the waste streams generated from each alternative. The sewer connection selected for each is described below.

- **RCF System** – Residuals would consist primarily of spent backflush following thickening from the lamella plate settlers (if sewer disposal is allowable for this waste stream) and municipal waste from staff facilities (i.e., sinks, showers, restroom facilities). A new 6-inch pipeline wastewater pipeline would connect to the existing 15-inch sewer on South 1st Street.
- **WBA System** - Residuals would consist primarily of municipal waste from staff facilities and water used during resin change out activities. A new 6-inch wastewater pipeline would connect to the existing 15-inch sewer on South 1st Street.
- **SBA System** - Residuals would consist primarily of spent brine (if sewer disposal is allowable for this waste stream) and municipal waste from staff facilities. Due to the volume of spent brine from the new 8-inch wastewater pipeline would connect to the existing sewer lift station located at the intersection of Orange Ave. and South 1st Street. If disposal of the spent brine to the sewer is not allowable (i.e., if spent brine is hauled offsite as liquid waste or discharged to evaporation ponds), a 6-inch diameter wastewater pipeline would be installed connecting to the existing 15-inch sewer on South 1st Street.
- **RO System** – Residuals would consist primarily of RO brine (if sewer disposal is allowable for this waste stream), spent CIP chemicals, and municipal waste from staff facilities. Due to the volume of RO brine generated from the process, approximately 9,400 lineal feet of new 21-inch pipeline would be installed and connect to the existing 33-inch sewer trunk line at the intersection Sycamore Ave. and Walnut Ave. The new pipeline would cross the treatment facility parcel boundary on the easterly side to Locust Ave. The alignment would turn northerly along Locust Ave. to Orange Ave. The alignment would turn easterly along Orange Ave. to its intersection with Sycamore Ave., after which it would turn northerly along Sycamore Ave. until its connection location at Walnut Ave. Figure 5-6 shows the conceptual routing for this alignment. If disposal of the RO brine to the sewer is not allowable (i.e., RO brine is discharged to evaporation ponds), a 6-inch diameter wastewater pipeline would be routed westerly to connect to the existing 15-inch sewer on South 1st Street.

Figure 5-6: Conceptual Residual Disposal Pipeline for Centralized RO System



Chapter 6 Cost Analysis

As the basis for comparing the alternatives, 34-year (2017 through 2050) lifecycle costs were developed for the available wellhead and centralized treatment options. The procedure used to develop the lifecycle cost for each treatment alternative and siting option is as follows:

- Obtained budget quotations for full-scale vendor equipment in the region and corresponding O&M costs, historical construction estimates and cost data, and RMC experience with similar projects.
- Developed opinions of probable construction costs include materials, equipment, labor, and services necessary to build the proposed projects. Unit costs to also include contractor overhead and profit, and bonds and insurance. Unit costs are intended to represent median prices submitted by responsible bidders.
- Developed the annual O&M costs for each treatment alternative.
- Performed a net present value (NPV) analysis for the 34-year lifecycle. This analysis will apply inflation and discount factors for future years as appropriate, accounting for future annual O&M costs, additional capital costs for treatment capacity expansion (i.e., additional well head treatment systems as new wells are added for well head alternatives to meet growing potable demand; expansion of the centralized facility alternatives to the 2050 capacity), and O&M activities that occur on a non-annual basis (e.g., membrane and treatment media replacement).
- Estimated the lifecycle cost for each system (i.e., opinion of constructed cost + NPV 34-year O&M cost).

The unit cost factors used to develop the O&M component of the lifecycle cost analysis for each treatment alternative are presented in Table 6-1.

Table 6-1: Unit Cost Factors for Lifecycle Analysis

Parameter	Unit	Value	Comment
Operational Costs:			
Electricity	$/kW-hr	$ 0.16	Average of current annual average rates for the City
Labor	$/hr	$ 38.00	Fully loaded cost of current City Level 3 operator
Solid Waste (Non-Hazardous)	$/wet ton	$ 43	Regional market rate
Non-RCRA Hazardous Waste	$/wet ton	$ 140	Estimate from Clean Harbors
SBA Regenerate - Liquid Haul Disposal	$/gal	$ 0.21	Contractor Estimate for hauling to EBMUD with 4,000 gallon trucks ($0.16/gallon), Estimate from EBMUD for Process Water Disposal ($0.05/gallon), 2016.
Annual Equipment O&M	-----	2%	Percent of Installed Equipment Cost.
Chemicals:			
SBA Resin Regeneration Salt	$/ton	$ 90.00	Vendor cost estimate of $0.45/lb
Polymer	$/lb	$ 4.00	Rounded up from $3.91 cost for YVWD
Sodium Bisulfate	$/gal	$ 1.32	Cost estimate based on other regional municipalities
Sodium Hydroxide	$/gal	$ 2.50	Cost estimate based on other regional municipalities
RO Antiscalant	$/gal	$ 16.82	Cost estimate based on other regional municipalities
Carbon Dioxide	$/ MG of water treated	$ 195.43	Estimated from Water Research Foundation, Assessment of Ion Exchange Media, Adsorptive Media, and RCF for Cr (VI) Removal, 2015.
Ferrous Sulfate	$/gal	$ 1.25	Delivered cost, estimated by chemical manufacturer
Sodium Hypochlorite	$/gal	$ 0.40	Cost estimate based on other regional municipalities
Citric Acid	$/gal	$ 6.04	Cost estimate based on other regional municipalities
Other Consumables:			
Catridge Filter Elements	Each	$ 23	Vendor Quotation
UF Membrane	Module	$ 1,850	Vendor Quotation
RO Element	Each	$ 650	Vendor Quotation
WBA Resin Replacement	CF	$ 524	Vendor Quotation
SBA Resin Replacement	CF	$ 203	Vendor Quotation
Decarbonator Media	CF	$ 45	Vendor Quotation
Capital Cost Factors:			
Electrical (Division 16)	-----	20%	Percent of Installed Equipment Cost.
Instrumentation and Control (Division 16)	-----	20%	Percent of Installed Equipment Cost.
Construction Contingency	-----	25%	Based on experience and related water treatment projects
General Contractor Overhead and Profit	-----	15%	Based on experience and related water treatment projects
Owner's Reserve for Change Orders	-----	15%	Based on experience and related water treatment projects
Environmental Documents and Permitting	-----	10%	Based on experience and related water treatment projects
Engineering Services (Design)	-----	15%	Based on experience and related water treatment projects
Construction Management	-----	13%	Based on experience and related water treatment projects
Engineering Services During Construction	-----	12%	Based on experience and related water treatment projects
Life Cycle Factors:			
Lifecycle Duration	year	34	No. of years through 2050
Inflation Rate	-----	3%	Based on experience and related water treatment projects
Discount Rate	-----	5.5%	Based on experience and related water treatment projects

Note that all costs in this analysis were developed on a conceptual level (i.e., -50%/+100%) in accordance with Class 5 estimates as defined by the Association for the Advancement of Cost Engineering, International (AACEI) publication 56R-08.

6.1 Well Head Treatment Alternatives

Due to the differences between well head sites and unknowns associated with future well capacities and locations, a parametric approach was used to develop the lifecycle costs for the well head treatment options. This approach entailed developing conceptual capital, O&M, and lifecycle costs for the reference 1,000 gpm well head treatment system for each BAT presented in Chapter 4. These costs were then equally

applied to each well head location to arrive at the costs for system-wide well head treatment. Described below is the methodology used to develop the costs for each well head treatment alternative.

Capital Cost Development

A conceptual level capital cost was developed in accordance with the 1,000 gpm reference system for each BAT alternative presented in Chapter 4. The reference system cost for each BAT alternative was then multiplied by 7 for the seven existing potable wells to arrive at the conceptual capital cost for the initial system-wide well head conceptual capital cost.

Note that within the initial years of the treatment system lifecycle analysis, the potable demand is projected to begin exceeding the supply capacity of the existing potable wells requiring the addition of new wells and corresponding treatment. For RCF, WBA, and SBA, this is expected to begin in year 7 of the lifecycle (2024). For RO, this is expected occur sooner (year 3 or 2020) due to the loss of a portion of the well production capacity as RO brine. To meet the demand increase for the years indicated, this analysis assumed that a new 1,200 gpm potable well was added to the potable system along with a well head Chrome 6 treatment system. The addition of new wells and corresponding treatment systems were assumed to continue as needed through the year 2050 to meet the increases in projected annual potable demand.

The capital costs for the well head treatment of future wells were accounted for as follows:

- For each future 1,200 gpm well added to the potable system, the capital cost for a new 1,000 gpm well head treatment system was added to the lifecycle analysis in the year of new well installation. The non-treated 200 gpm of flow capacity from the well was assumed for blending to meet the 0.005 mg/L Chrome 6 goal in the product water.
- Costs for the new well and corresponding new well conveyance piping were not included, as these costs are outside the scope of this Feasibility Study.

O&M Cost Development

Using the O&M cost factors shown in Table 6-1, the following procedure was used to develop the conceptual O&M costs:

1. O&M costs incurred in proportion to the flow treated were developed based on the annual potable demand for each year in the lifecycle as identified in the City Water Supply Master Plan. These include electrical power for pumping, chemical consumption, and residual waste disposal.
2. O&M costs incurred on an annual basis that are not directly proportional to flow treated were applied uniformly for each year in the lifecycle. These include labor, equipment maintenance and repair, and CIP activities (as applicable). With the addition of each future well, these costs were increased as follows:
    a. The labor required for treatment operations was assumed to increase by one 0.5 Full Time Equivalent (FTE) for each new well added beyond the 7 current potable wells in service.
    b. O&M costs for equipment maintenance and repair and CIP activities were increased in linear proportion for each future well added to the potable system.
3. O&M costs incurred on a non-annual basis were applied in the year requiring the O&M activity. These include membrane and media replacement (as applicable) and replacement of equipment with projected lives shorter than the 34-year lifecycle analysis interval (e.g. pumps).
4. The costs developed for steps (1) through (3) above were summed to yield the conceptual O&M cost for each year in the lifecycle for each BAT alternative.

Net Present Value (NPV) and Lifecycle Cost Development

The lifecycle cost for each well head treatment alternative was generated using the following procedure:

- The conceptual capital cost for the treatment systems of the initial seven wells and corresponding total annual O&M cost were summed to yield the total cost for the initial year.
- For each future year, the conceptual capital cost for future treatment (for years of new well installation) and total annual O&M cost were summed and escalated for inflation to yield a total annual cost. The escalated future costs were estimated by applying the inflation rate cited in Table 6-1.
- The NPV of the total annual cost for each year in the lifecycle was calculated. This was done by applying the discount factor cited in Table 6-1 to convert all future year costs to 2016 equivalent dollars.
- The NPV cost of each year in the lifecycle was summed to yield the NPV lifecycle cost for the BAT alternative.

6.1.2 Capital Costs

The conceptual level opinions of probable construction cost for the well head BAT alternatives is presented in Table 6-2. The detailed breakdown for each opinion of probable construction cost is included in the Appendix.

Table 6-2: Opinions of Probable Construction Cost for Well Head Treatment

Spec. Division	Cost (2016 $) RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA[a]	RO[a]
1 - General Requirements	$ 526,000	$ 561,000	$ 373,000	$ 343,000	$ 439,000
2 - Sitework	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000
3 - Concrete	$ 22,000	$ 33,000	$ 9,000	$ 11,000	$ 17,000
5 - Metals	$ 20,000	$ 20,000	$ 13,000	$ 33,000	$ 48,000
11 - Equipment	$ 3,172,000	$ 3,390,000	$ 2,293,000	$ 1,311,000	$ 2,474,000
13 - Special Construction	$ 210,000	$ 223,000	$ 26,000	$ 1,173,000	$ 364,000
15 - Mechanical	$ 317,000	$ 339,000	$ 229,000	$ 131,000	$ 247,000
16 - Electrical	$ 634,000	$ 678,000	$ 458,000	$ 262,000	$ 495,000
17 - Instrumentation and Control	$ 634,000	$ 678,000	$ 458,000	$ 262,000	$ 495,000
Raw Construction Subtotal	$ 5,785,000	$ 6,172,000	$ 4,109,000	$ 3,776,000	$ 4,829,000
Construction Contingency (25%)	$ 1,447,000	$ 1,543,000	$ 1,028,000	$ 944,000	$ 1,208,000
Construction Cost Subtotal	$ 7,232,000	$ 7,715,000	$ 5,137,000	$ 4,720,000	$ 6,037,000
Tax on Materials (9%)	$ 326,000	$ 348,000	$ 232,000	$ 213,000	$ 272,000
General Contractor Overhead and Profit (15%)	$ 1,085,000	$ 1,158,000	$ 771,000	$ 708,000	$ 906,000
Estimated Total Construction Cost (Single Well)	**$ 8,643,000**	**$ 9,221,000**	**$ 6,140,000**	**$ 5,641,000**	**$ 7,215,000**
Owner's Reserve for Change Orders (15%)	$ 1,297,000	$ 1,384,000	$ 921,000	$ 847,000	$ 1,083,000
Environmental Documents and Permitting (10%)	$ 865,000	$ 923,000	$ 614,000	$ 565,000	$ 722,000
Engineering Design Services (15%)	$ 1,297,000	$ 1,384,000	$ 921,000	$ 847,000	$ 1,083,000
Construction Management (13%)	$ 1,124,000	$ 1,199,000	$ 799,000	$ 734,000	$ 938,000
Engineering Services During Construction (12%)	$ 1,038,000	$ 1,107,000	$ 737,000	$ 677,000	$ 866,000
Estimated Total Capital Cost (Single Well)	**$ 14,264,000**	**$ 15,218,000**	**$ 10,132,000**	**$ 9,311,000**	**$ 11,907,000**
Estimated Total Construction Cost (7 Wells)	**$ 60,501,000**	**$ 64,547,000**	**$ 42,980,000**	**$ 39,487,000**	**$ 50,505,000**
Estimated Total Capital Cost (7 Wells)	**$ 99,848,000**	**$ 106,526,000**	**$ 70,924,000**	**$ 65,177,000**	**$ 83,349,000**

Footnotes:

a. Does not include costs for evaporation ponds. Cost analysis for evaporation ponds as a disposal alternative was not included in the scope of the project.

The Estimated Total Construction Cost represents the value for a contractor "bid" cost. The Estimated Total Capital Cost includes the soft costs associated with project development and carrying project construction through completion; these costs include engineering, permitting and environmental requirements, construction management and related services, and an owner's contingency to allow for change orders during construction. Additionally, the RCF alternative shows two capital costs, as the landfill disposal option requires additional equipment for dewatering. This disposal option requires the addition of a sludge holding tank, screw press, and dewatered solids holding bins.

6.1.3 O&M Costs

The conceptual level O&M costs for the well head BAT alternatives is presented in Table 6-3. The detailed breakdown of conceptual O&M costs associated with each alternative is included in the Appendix.

Table 6-3: O&M Costs for Well Head Treatment

Cost Component	Interval (year)	Cost (2016 $) RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA Sewer Disposal	SBA Liquid Waste Haul Disposal	RO
Routine O&M Costs							
Repair and Maintenance (per well)	Annual	$ 64,000	$ 68,000	$ 46,000	$ 27,000	$ 27,000	$ 50,000
Cartridge Filter Replacement (per well)	Annual	$ -	$ -	$ 63,000	$ 63,000	$ 63,000	$ 31,000
Power (per well)	Annual	$ 109,200	$ 109,400	$ 56,000	$ 56,000	$ 56,000	$ 222,700
Chemicals (per well)	Annual	$ 19,400	$ 19,400	$ 103,000	$ 212,000	$ 212,000	$ 41,000
Disposal (per well)	Annual	$ -	$ 3,000	$ -	$ -	$ 1,061,000	$ -
Subtotal per Well	*Annual*	*$ 192,600*	*$ 199,800*	*$ 268,000*	*$ 358,000*	*$ 1,419,000*	*$ 344,700*
No. of Potable Wells	-----	7	7	7	7	7	$ 7
Subtotal for System	*Annual*	*$ 1,348,200*	*$ 1,398,600*	*$ 1,876,000*	*$ 2,506,000*	*$ 9,933,000*	*$ 2,412,900*
Labor for System	Annual	$ 315,000	$ 315,000	$ 158,000	$ 236,000	$ 236,000	$ 236,000
Total Routine O&M Cost for System	**Annual**	**$ 1,663,200**	**$ 1,713,600**	**$ 2,034,000**	**$ 2,742,000**	**$ 10,169,000**	**$ 2,648,900**
Non-Annual O&M Cost Components (per well)							
UF Membrane Replacement	3	$ 141,000	$ 141,000	$ -	$ -	$ -	$ 141,000
RO Membrane Replacement	5	$ -	$ -	$ -	$ -	$ -	$ 150,000
WBA Resin Replacement	1.8	$ -	$ -	$ 444,000	$ -	$ -	$ -
WBA Resin Disposal	1.8	$ -	$ -	$ 1,000	$ -	$ -	$ -
SBA Resin Replacement	7	$ -	$ -	$ -	$ 85,900	$ 85,900	$ -
SBA Resin Disposal	7	$ -	$ -	$ -	$ 360	$ 360	$ -
Decarbonator - Media Replacement	20	$ -	$ -	$ 19,000	$ -	$ -	$ -
Pump Replacement	10	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 125,000	$ 228,000

Footnotes:

a. O&M costs for disposal of SBA spent brine and RO brine through evaporation ponds were not evaluated. Cost analysis for evaporation ponds was not included in the scope of the project.

Note that the annual initial labor varies for each alternative and is based on the following:

- 4 FTE were assumed for the initial RCF treatment system (i.e., for 7 wells), as this process is the most complex of the alternatives and has the most number of unit operations in the treatment process.
- 3 FTE were assumed for the initial well head SBA and RO treatment systems.
- 2 FTE were assumed for the initial well head WBA treatment system, as this treatment process is the least complex of the systems evaluated.

6.1.4 Lifecycle Analysis

The conceptual level lifecycle analysis for the well head BAT alternatives is presented in Table 6-4. The detailed breakdown of the lifecycle cost calculation for each alternative is included in the Appendix.

Table 6-4: Lifecycle Costs for Well Head Treatment

Cost Component	Cost (2016 $)					
	RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA Sewer Disposal	SBA Liquid Waste Haul Disposal	RO
Estimated Total Construction Cost (7 Wells)	$ 60,501,000	$ 64,547,000	$ 42,980,000	$ 39,487,000	$ 39,487,000	$ 50,505,000
Estimated Total Capital Cost (7 Wells)	$ 99,848,000	$ 106,526,000	$ 70,924,000	$ 65,177,000	$ 65,177,000	$ 83,349,000
NPV O&M Costs						
Routine Annual Costs for Lifecycle	$ 35,233,000	$ 36,399,000	$ 43,869,000	$ 53,244,000	$ 163,386,000	$ 47,873,000
Non-Annual Costs for Lifecycle	$ 6,678,000	$ 6,678,000	$ 33,327,000	$ 3,860,000	$ 3,860,000	$ 18,159,000
Treatment Capacity Expansion for New Wells						
Total Wells Added over Lifecycle	6	6	6	6	6	8
NPV Estimated Total Capital Cost for New Well Treatment	$ 54,747,000	$ 58,409,000	$ 38,888,000	$ 35,737,000	$ 35,737,000	$ 55,115,000
NPV for Alternative	**$ 196,506,000**	**$ 208,012,000**	**$ 187,008,000**	**$ 158,018,000**	**$ 268,160,000**	**$ 204,496,000**

Footnotes:

a. Does not include costs for evaporation ponds as a disposal alternative for SBA spent brine and RO brine. Cost analysis for evaporation ponds was not included in the scope of the project.

Note that 6 future wells to meet projected demands for the RCF, WBA, and SBA alternatives, whereas 8 future wells are needed for RO. This is due to the nature of RO where 18% of the well supply capacity is lost as RO brine discharged to waste. As noted earlier, the values shown for the NPV Estimated Total Capital Cost for New Well Treatment does not include the costs for the future wells and associated new conveyance pipelines.

6.1.5 Findings for Well Head Cost Analysis

The costs analysis shows SBA with disposal of spent brine to the sewer to be the most cost effective well head treatment alternative. The analysis shows SBA with sewer disposal to have the lowest conceptual costs for both Estimated Total Capital ($65.2 million) and lifecycle ($158 million). However, there are two key items which would need to addressed with this alternative:

- Space Limitations – The conceptual system footprint requirements estimated in Chapter 4.3 indicate that only the site at Well No. 11 has sufficient space for a SBA treatment system. Well No. 8 is marginal for space, and all other well locations have insufficient space.
- Spent brine disposal.
    - Disposal to Sewer – This would be the preferred option. However, it is unclear if the Patterson WQCF can accept the spent brine due to its high TDS (anticipated to be at or above 10,000 mg/L). Further discussions with City staff would be needed to determine if sewer disposal of spent brine can be allowed.
    - Liquid waste hauling to EBMUD – This option is not a cost effective alternative to sewer disposal, as it increases the SBA lifecycle cost by approximately 70%. This would move SBA from most cost effective to the least cost effective well head treatment alternative.
    - Evaporation Ponds – As noted earlier, conceptual costs for evaporation ponds and associated conveyance piping for SBA brine disposal were not developed in this report. Development of costs would be advised if the conceptual estimated pond acreage (9.5 acres initial; 17 acres at 2050) is acceptable and well head SBA treatment is considered beyond this effort.

If well head SBA treatment cannot be considered due to available space and/or brine management issues, the cost analysis shows WBA to be the second lowest lifecycle cost well head treatment alternative. The

conceptual Estimated Total Capital and lifecycle costs for this alternative are approximately $70.9 million and $187 million, respectively.

6.2 Centralized Facility Alternatives

Opinions of probable construction cost, O&M costs, and lifecycle costs were developed explicitly for conceptual level. Described below is the methodology used to develop the costs for each centralized treatment alternative.

Capital Cost Development

The opinion of probable construction cost for each centralized facility alternative was developed based on the facility and treatment equipment sizing criteria described in Chapter 5. Costs for the expansion to the 2050 facility capacity were assumed to occur in the year 2030. The cost for the capacity expansion was calculated using the cost for the treatment equipment of the initial system and scaling the cost proportionally for the new treatment capacity added in the expansion.

O&M Cost Development

O&M cost were developed using the same basis as described for the well head treatment alternatives. However, labor was not assumed to increase following the facility expansion to the 2050 capacity, as the labor increases needed to manage increasing multiple individual sites for the well head alternatives do not apply to a centralized facility.

Net Present Value (NPV) and Lifecycle Cost Development

The lifecycle cost for each centralized treatment alternative was generated using the following procedure:

- The conceptual capital cost for the initial treatment system and corresponding total annual O&M cost were summed to yield the total cost for the initial year.
- The base O&M cost for each future year was escalated for inflation to yield a total annual cost. The escalated future costs were estimated by applying the inflation rate cited in Table 6-1. For the year 2030, the conceptual capital cost for the expansion to the 2050 facility capacity was escalated for inflation and added to the 2030 total annual cost.
- The NPV of the total annual cost for each year in the lifecycle was calculated. This was done by applying the discount factor cited in Table 6-1 to convert all future year costs to 2016 equivalent dollars.
- The NPV cost of each year in the lifecycle was summed to yield the NPV lifecycle cost for the BAT alternative.

6.2.2 Capital Costs

The conceptual level opinions of probable construction cost for the centralized facility BAT alternatives is presented in Table 6-5. The detailed breakdown for each opinion of probable construction cost is included in the Appendix.

Table 6-5: Opinions of Probable Construction Cost for Centralized Treatment

Spec. Division	Cost (2016 $) RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA[a]	RO[a]
1 - General Requirements	$ 4,704,000	$ 4,743,000	$ 2,947,000	$ 3,089,000	$ 4,630,000
2 - Sitework	$ 2,500,000	$ 2,500,000	$ 2,500,000	$ 2,500,000	$ 2,500,000
3 - Concrete	$ 214,000	$ 264,000	$ 150,000	$ 339,000	$ 169,000
5 - Metals	$ 78,000	$ 78,000	$ 79,000	$ 76,000	$ 85,000
11 - Equipment	$ 22,682,000	$ 22,900,000	$ 13,232,000	$ 11,939,000	$ 19,591,000
13 - Special Construction	$ 10,225,000	$ 10,236,000	$ 1,248,000	$ 4,233,000	$ 2,074,000
15 - Mechanical	$ 2,268,000	$ 2,290,000	$ 1,323,000	$ 1,194,000	$ 1,959,000
16 - Electrical	$ 4,536,000	$ 4,580,000	$ 3,970,000	$ 2,388,000	$ 3,918,000
17 - Instrumentation and Control	$ 4,536,000	$ 4,580,000	$ 2,646,000	$ 2,388,000	$ 3,918,000
Raw Construction Subtotal	$ 51,743,000	$ 52,171,000	$ 28,095,000	$ 28,146,000	$ 38,844,000
Construction Contingency (25%)	$ 12,936,000	$ 13,043,000	$ 7,024,000	$ 7,037,000	$ 9,711,000
Construction Cost Subtotal	$ 64,679,000	$ 65,214,000	$ 35,119,000	$ 35,183,000	$ 48,555,000
Tax on Materials (9%)	$ 2,911,000	$ 2,935,000	$ 1,581,000	$ 1,584,000	$ 2,185,000
General Contractor Overhead and Profit (15%)	$ 9,702,000	$ 9,783,000	$ 5,268,000	$ 5,278,000	$ 7,284,000
Estimated Total Construction Cost	**$ 77,292,000**	**$ 77,932,000**	**$ 41,968,000**	**$ 42,045,000**	**$ 58,024,000**
Owner's Reserve for Change Orders (15%)	$ 11,594,000	$ 11,690,000	$ 6,296,000	$ 6,307,000	$ 8,704,000
Environmental Documents and Permitting (10%)	$ 7,730,000	$ 7,794,000	$ 4,197,000	$ 4,205,000	$ 5,803,000
Engineering Design Services (15%)	$ 11,594,000	$ 11,690,000	$ 6,296,000	$ 6,307,000	$ 8,704,000
Construction Management (13%)	$ 10,048,000	$ 10,132,000	$ 5,456,000	$ 5,466,000	$ 7,544,000
Engineering Services During Construction (12%)	$ 9,276,000	$ 9,352,000	$ 5,037,000	$ 5,046,000	$ 6,963,000
Estimated Total Construction Cost	**$ 127,534,000**	**$ 128,590,000**	**$ 69,250,000**	**$ 69,376,000**	**$ 95,742,000**

Footnotes:

a. Does not include costs for evaporation ponds. Cost analysis for evaporation ponds as a disposal alternative was not included in the scope of the project.

As described earlier in Chapter 6.1.2, the Estimated Total Construction Cost represents the value for a contractor "bid" cost. The Estimated Total Capital Cost includes the soft costs associated with project development and carrying project construction through completion. Additionally, the RCF alternative shows two capital costs, as the landfill disposal option requires additional equipment for dewatering. This disposal option requires the addition of a sludge holding tank, screw press, and dewatered solids holding bins.

6.2.3 O&M Costs

The conceptual level O&M costs for the centralized BAT alternatives is presented in Table 6-6. The detailed breakdown of conceptual O&M costs associated with each alternative is included in the Appendix.

Table 6-6: O&M Costs for Centralized Treatment

Cost Component	Interval (year)	Cost (2016 $) RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA Sewer Disposal	SBA Liquid Waste Haul Disposal	RO
Routine O&M Costs for Initial Capacity							
Repair and Maintenance	Annual	$ 454,000	$ 458,000	$ 265,000	$ 239,000	$ 239,000	$ 392,000
Cartridge Filter Replacement	Annual	$ -	$ -	$ 426,000	$ 426,000	$ 426,000	$ 213,000
Power	Annual	$ 1,048,000	$ 1,048,000	$ 620,000	$ 562,000	$ 562,000	$ 1,617,718
Chemicals	Annual	$ 155,000	$ 155,000	$ 678,000	$ 1,530,000	$ 1,530,000	$ 885,000
Disposal	Annual	$ -	$ 19,000	$ -	$ -	$ 6,957,000	$ -
Labor	Annual	$ 315,000	$ 315,000	$ 158,000	$ 236,000	$ 236,000	$ 236,000
Total Routine O&M Costs	**Annual**	**$ 1,972,000**	**$ 1,995,000**	**$ 2,147,000**	**$ 2,993,000**	**$ 9,950,000**	**$ 3,343,718**
Non-Annual O&M Cost Components							
UF Membrane Replacement	3	$ 833,000	$ 833,000	$ -	$ -	$ -	$ 833,000
RO Membrane Replacement	5	$ -	$ -	$ -	$ -	$ -	$ 983,000
WBA Resin Replacement	1.8	$ -	$ -	$ 1,986,000	$ -	$ -	$ -
WBA Resin Disposal	1.8	$ -	$ -	$ 11,000	$ -	$ -	$ -
SBA Resin Replacement	7	$ -	$ -	$ -	$ 526,000	$ 526,000	$ -
SBA Resin Disposal	7	$ -	$ -	$ -	$ 2,000	$ 2,000	$ -
Decarbonator - Media Replacement	20	$ -	$ -	$ 130,000	$ -	$ -	$ -
Pump Replacement	10	$ 472,000	$ 472,000	$ 475,446	$ 457,000	$ 457,000	$ 533,236

Footnotes:

a. O&M costs for disposal of SBA spent brine and RO brine through evaporation ponds were not evaluated. Cost analysis for evaporation ponds was not included in the scope of the project.

Note that the annual initial labor varies for each alternative and is based on the following:

- 4 FTE were assumed for the centralized RCF facility, as this process is the most complex of the alternatives and has the most number of unit operations in the treatment process.
- 3 FTE were assumed for the centralized SBA and RO treatment facilities.
- 2 FTE were assumed for the centralized WBA treatment facility, as this treatment process is the least complex of the systems evaluated.

6.2.4 Lifecycle Analysis

The conceptual level lifecycle analysis for the centralized BAT alternatives is presented in Table 6-7. The detailed breakdown of the lifecycle cost calculation for each alternative is included in the Appendix.

Table 6-7: Lifecycle Costs for Centralized Treatment

Cost Component	Cost (2016 $)					
	RCF Sewer Disposal	RCF Landfill Disposal	WBA	SBA Sewer Disposal	SBA Liquid Waste Haul Disposal	RO
Estimated Total Construction Cost	$ 77,292,000	$ 77,932,000	$ 41,968,000	$ 42,045,000	$ 42,045,000	$ 58,024,000
Estimated Total Capital Cost	$ 127,534,000	$ 128,590,000	$ 69,250,000	$ 69,376,000	$ 69,376,000	$ 95,742,000
NPV O&M Costs						
Routine Annual Costs for Lifecycle	$ 36,742,000	$ 37,099,000	$ 42,523,000	$ 52,694,000	$ 146,768,000	$ 54,391,000
Non-Annual Costs for Lifecycle	$ 8,502,000	$ 8,502,000	$ 33,011,000	$ 2,752,000	$ 2,752,000	$ 12,981,000
NPV Estimated Total Capital Cost for Expansion to 2050 Capacity	$ 31,076,000	$ 31,076,000	$ 30,659,000	$ 11,031,000	$ 11,031,000	$ 16,736,000
NPV for Alternative	**$ 203,854,000**	**$ 205,267,000**	**$ 175,443,000**	**$ 135,853,000**	**$ 229,927,000**	**$ 179,850,000**

Footnotes:

a. Does not include costs for evaporation ponds as a disposal alternative for SBA spent brine and RO brine. Cost analysis for evaporation ponds was not included in the scope of the project.

Note that the "NPV Estimated Total Capital Cost for Expansion to 2050 Capacity" line item represents the expansion in plant treatment capacity from initial (i.e., 2030) to ultimate (i.e., 2050) capacity, and is assumed to occur in the year 2030.

6.2.5 Findings for Centralized Facility Cost Analysis

The findings from the costs analysis of the centralized treatment facility alternatives are as follows:

- WBA and SBA alternatives show the lowest Estimated Total Capital Cost ($69.3 million and $69.4 million, respectively)
- SBA with sewer disposal shows the lowest NPV cost of the centralized treatment alternatives at approximately $135.9 million.

Based on these findings, the SBA with sewer disposal appears to be the most cost effective centralized treatment option. However, as discussed earlier for the well head cost analysis, it is unclear if disposal of the SBA to the sewer may be allowable due to the high TDS of the brine. Further discussions with City staff would be needed to determine if sewer disposal of spent brine can be allowed

For SBA spent brine disposal alternatives if sewer disposal is not allowable:

- As was the case for the well head SBA analysis, liquid waste hauling increases the SBA lifecycle cost by approximately 70%. This would move SBA from most cost effective to the least cost effective treatment alternative.
- As noted earlier, conceptual costs for evaporation ponds and associated conveyance piping for SBA brine disposal were not developed in this report. Development of costs would be advised if the conceptual estimated pond acreage (9 acres initial; 14 acres at 2050) is acceptable and centralized SBA treatment is considered.

If SBA treatment cannot be considered due to brine management issues, the cost analysis shows WBA to be the second lowest lifecycle cost centralized treatment alternative. The conceptual Estimated Total Capital and lifecycle costs for this alternative are approximately $69.3 million and $175.4 million, respectively

6.3 Summary of Cost Analysis

Table 6-8 presents the summary of the cost analysis of the treatment alternatives for the well head and centralized facility siting options, with the lowest Total Estimated Capital Cost and NPV Lifecycle Cost highlighted in red.

Table 6-8: Summary of Cost Analysis

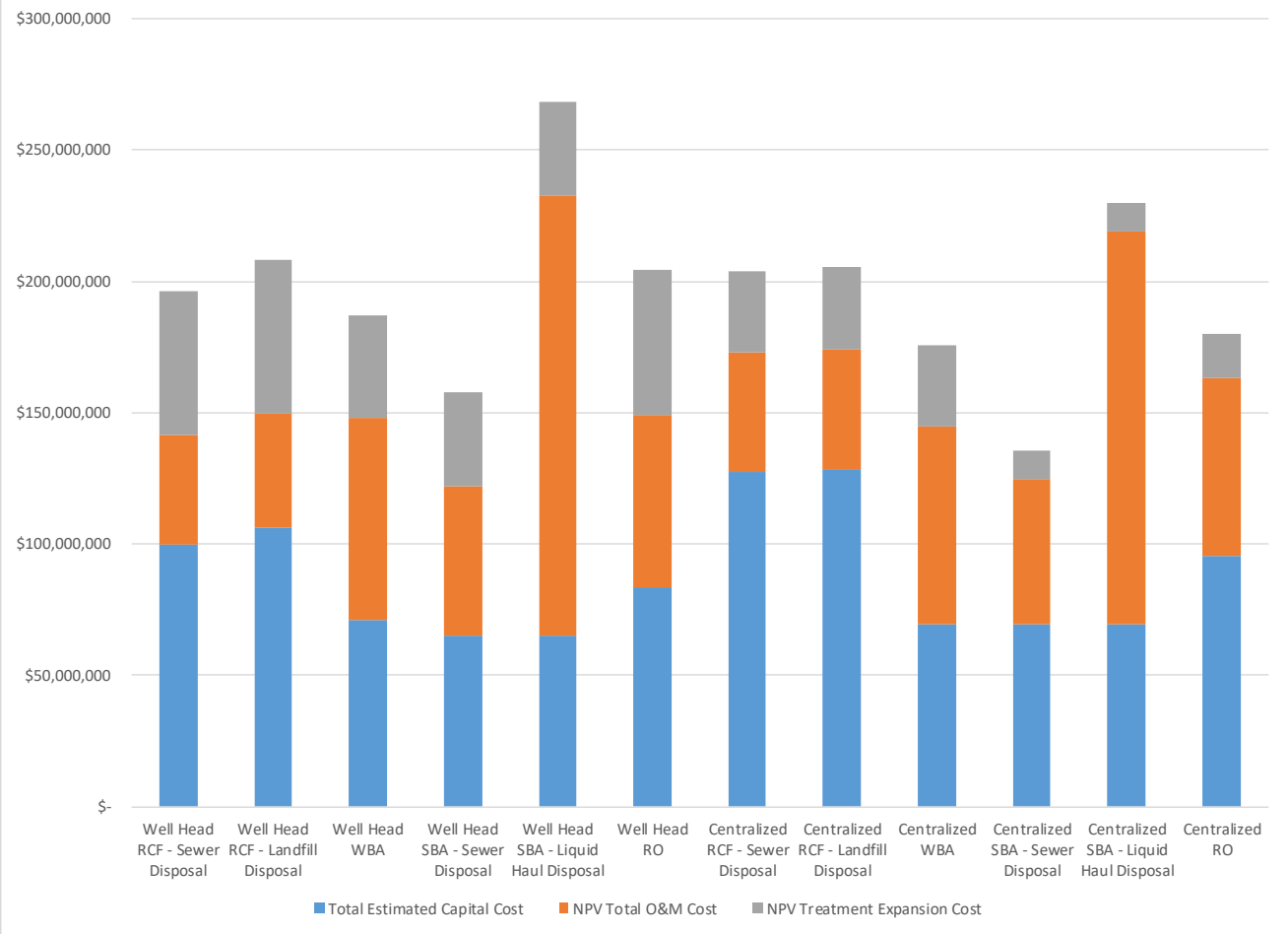
Treatment and Site Alternative	Cost (2016 $) Total Estimated Capital Cost	NPV Total O&M Cost	NPV Treatment Expansion Cost	NPV Lifecycle Cost
Well Head Treament				
RCF - Sewer Disposal	$ 99,848,000	$ 41,911,000	$ 54,747,000	$ 196,506,000
RCF - Landfill Disposal	$ 106,526,000	$ 43,077,000	$ 58,409,000	$ 208,012,000
WBA	$ 70,924,000	$ 77,196,000	$ 38,888,000	$ 187,008,000
SBA - Sewer Disposal	**$ 65,177,000**	**$ 57,104,000**	**$ 35,737,000**	**$ 158,018,000**
SBA - Liquid Haul Disposal	$ 65,177,000	$ 167,246,000	$ 35,737,000	$ 268,160,000
RO	$ 83,349,000	$ 66,032,000	$ 55,115,000	$ 204,496,000
Centralized Treatment				
RCF - Sewer Disposal	$ 127,534,000	$ 45,244,000	$ 31,076,000	$ 203,854,000
RCF - Landfill Disposal	$ 128,590,000	$ 45,601,000	$ 31,076,000	$ 205,267,000
WBA	**$ 69,250,000**	**$ 75,534,000**	**$ 30,659,000**	**$ 175,443,000**
SBA - Sewer Disposal	**$ 69,376,000**	**$ 55,446,000**	**$ 11,031,000**	**$ 135,853,000**
SBA - Liquid Haul Disposal	$ 69,376,000	$ 149,520,000	$ 11,031,000	$ 229,927,000
RO	$ 95,742,000	$ 67,372,000	$ 16,736,000	$ 179,850,000

Footnotes:

a. Does not include costs for evaporation ponds as a disposal alternative for SBA spent brine and RO brine. Cost analysis for evaporation ponds was not included in the scope of the project.

These findings are also presented graphically in Figure 6-1.

Figure 6-1: Lifecycle Cost Summary for Well Head vs. Centralized Chrome 6 Treatment



A comparison of the well head and centralized treatment alternative costs show the following:

- Well head SBA with sewer disposal is shown to have the lowest conceptual Total Estimated Capital Cost at approximately $65.2 million.
- Centralized SBA with sewer disposal is shown to have the lowest NPV Lifecycle Cost at approximately $135.9 million.
- The issues of space requirements (for well head SBA) and spent brine disposal (for both well head and centralized SBA) identified earlier could rule out SBA as a feasible treatment alternative. If this is the case, centralized WBA is shown as having the next lowest cost for both conceptual Total Estimated Capital Cost ($69.3 million) and NPV Lifecycle Cost ($175.4 million).

Chapter 7 Summary of Findings and Recommendations

This chapter summarizes the findings from TDS/nitrate analysis performed in Chapter 2, and the cost analysis for the Chrome 6 treatment alternatives and siting options performed in Chapters 3 through 6.

7.1.1 TDS and Nitrate Analysis

The water quality analysis performed in Chapter 2 for TDS and nitrate and the evaluation for the treatability of these constituents with the Chrome 6 BATs indicated the following:

- TDS:
    - The averages from 2014 through 2016 indicate that all of the potable wells exceed the 500 mg/L regulatory recommended goal.
    - Well Nos. 7 and 8 currently exceed the 1,000 mg/L secondary MCL upper limit.
    - Well Nos. 2 and 6 are projected to reach 1,000 mg/L by 2030.
    - The TDS for the aggregate potable system is projected to exceed 1,000 mg/L by 2030.
    - Well Nos. 5, 8, and 11 are projected to remain below 1,000 mg/L through 2050.
    - RCF, WBA, and SBA are not effective to treat TDS. RO is effective to treat TDS. Using RO to treat to the Chrome 6 product water goal will generate a product water with a projected TDS concentration of approximately 150 mg/L.
- Nitrate:
    - The averages from 2014 through 2016 indicate that Well Nos. 2 and 6 are projected to exceed the 45 mg/L MCL by the year 2050.
    - Well Nos. 5, 7, 8, 9, and 11 are projected to remain below 45 mg/L through 2050.
    - Nitrate for the aggregate potable system is projected to remain below 45 mg/L through 2050.
    - RCF, WBA, and SBA are not effective to treat nitrate. RO is effective to treat nitrate. Using RO to treat to the Chrome 6 product water goal will generate a product water with a projected nitrate concentration of less than 7.5 mg/L.

With the costs analysis suggesting either SBA or WBA be used for treatment of Chrome 6, separate treatment in the future would be needed to reduce TDS below 1,000 mg/L or to reach the recommended goal of 500 mg/L. Similarly, separate nitrate treatment for Well Nos. 2 and 6 prior to the year 2050 would be needed for those wells to remain below the 45 mg/L MCL. Combining of the water extracted from the wells at a centralized facility would eliminate the need for future nitrate treatment.

7.1.2 Cost Analysis

The cost analysis findings in Chapter 6.3 indicated several possible recommendations, with each dependent on addressing specific issues (i.e., space and residual disposal) and approach to cost management priority. The following presents the Chrome 6 treatment system recommendations, accounting for these factors.

Low Initial Cost Priority

If the cost driver is the initial cost to implement a treatment system, well head SBA would be recommended ($65.2 million Total Estimated Capital Cost). However, this recommendation is contingent on meeting the following additional requirements:

- Addressing the space limitation issues identified for the sites at Well Nos. 2, 5, 6, 7, 8, and possibly 9.
- Verifying that disposal of the spent brine to the sewer and the Patterson WQCF is possible. If not, determine if the evaporation pond space requirement (i.e. min. of 17 acres by 2050) is acceptable by the City. If so, estimate the requirements and costs for evaporation ponds to determine if the cost for this disposal option is acceptable.

If the space and/or the spent brine disposal issues rule out well head SBA treatment, centralized WBA would be recommended, as it is the next lowest initial cost alternative ($69.3 million Total Estimated Capital Cost).

Low Lifecycle Cost Priority

If the cost driver is lifecycle cost for the treatment system, centralized SBA would be recommended ($135.9 million NPV Lifecycle Cost). However, this recommendation is contingent on meeting the same spent brine disposal issues identified for the well head SBA treatment. If brine disposal rules out centralized SBA, centralized WBA would be recommended, as it is the next lowest lifecycle cost alternative ($175.4 million).

Chapter 8 References

8.1 Reports

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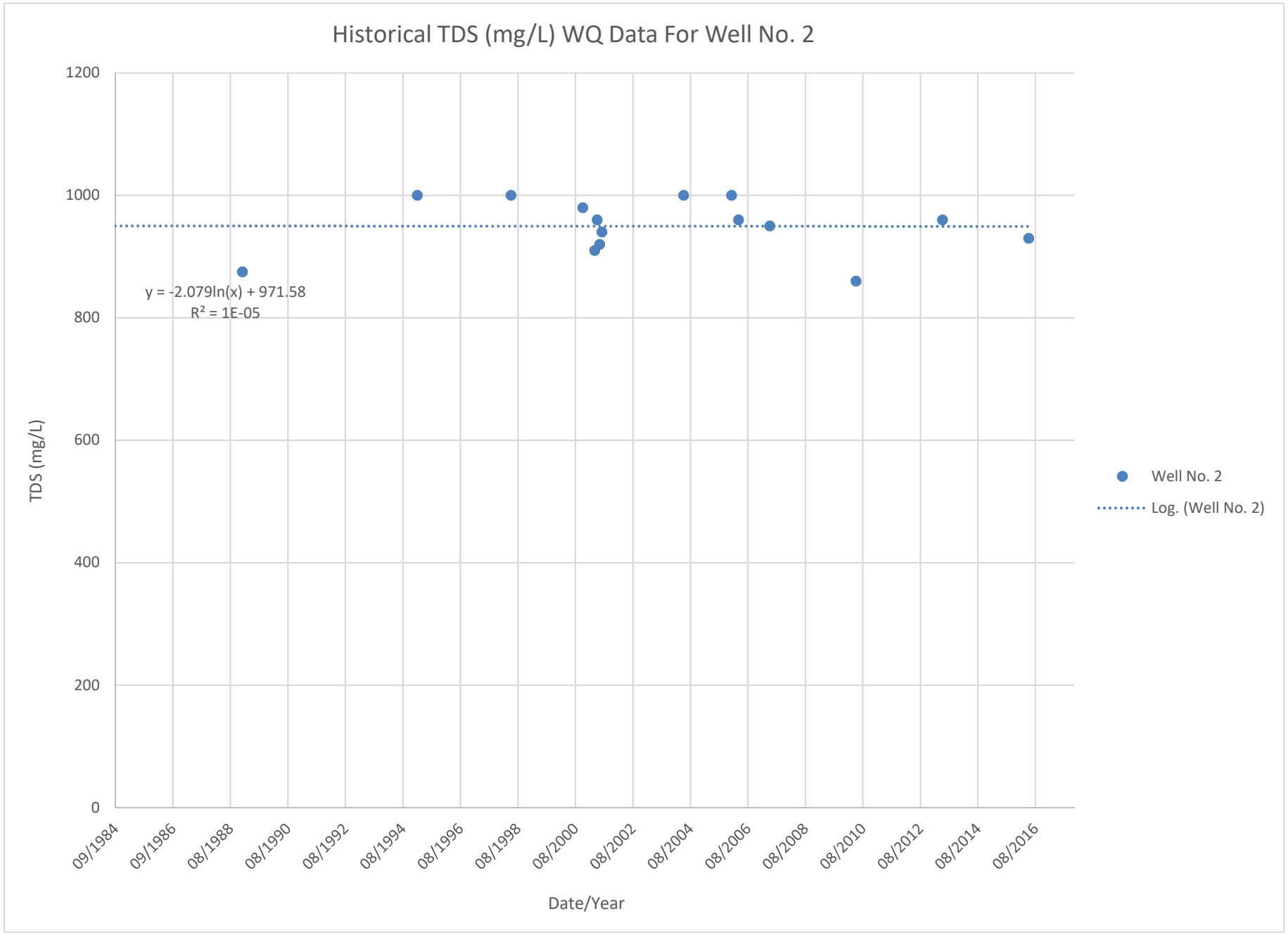
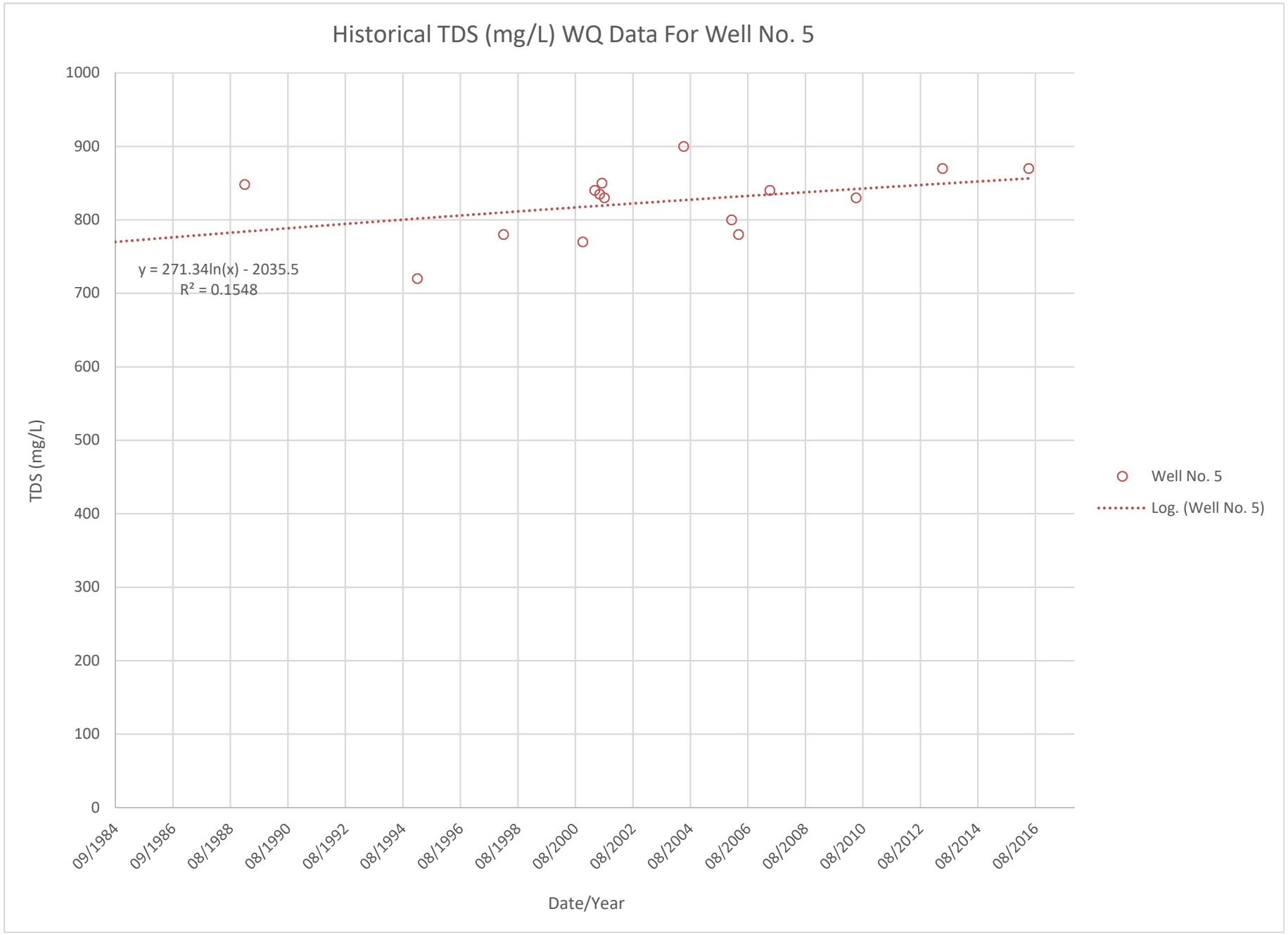
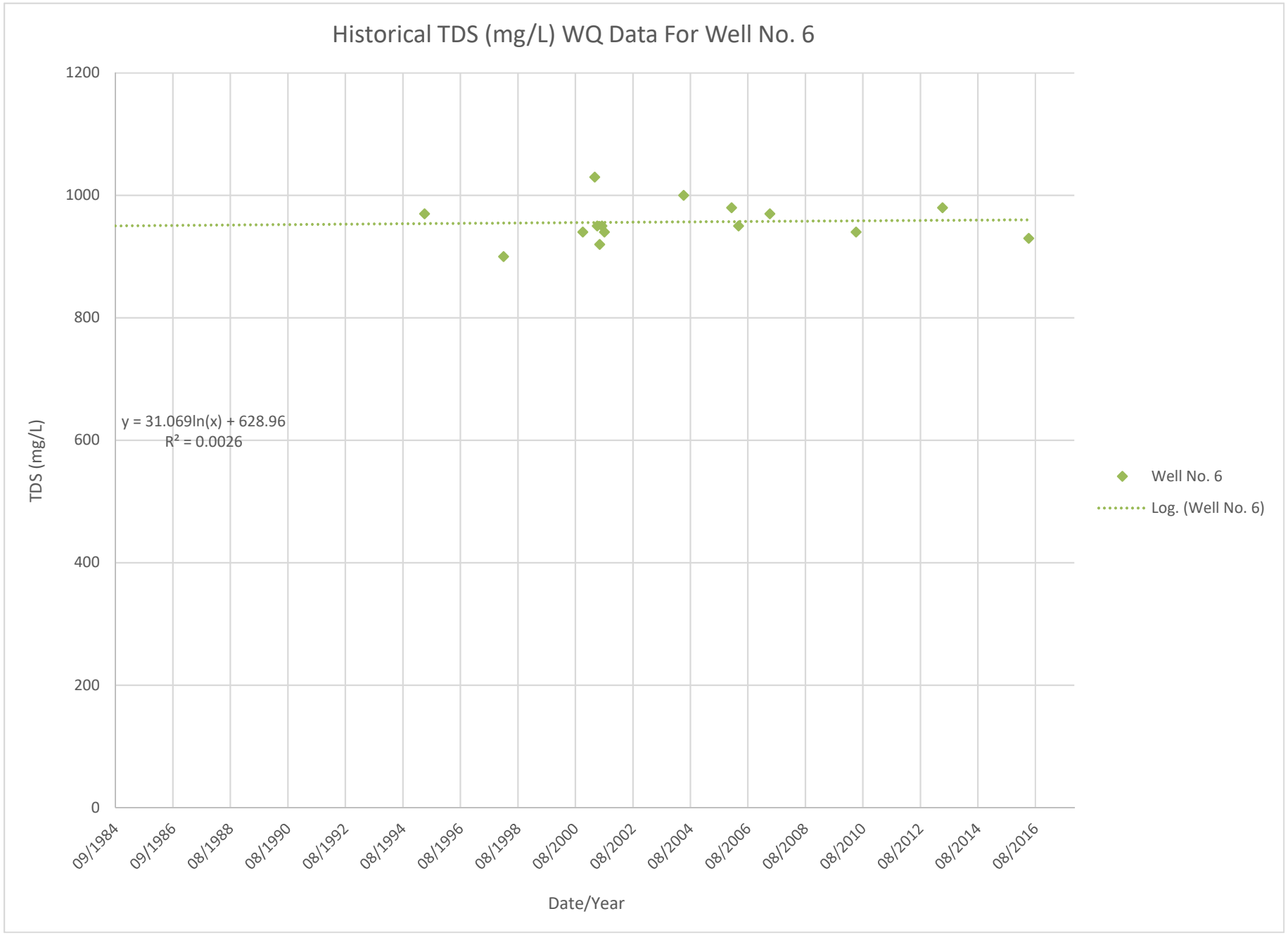
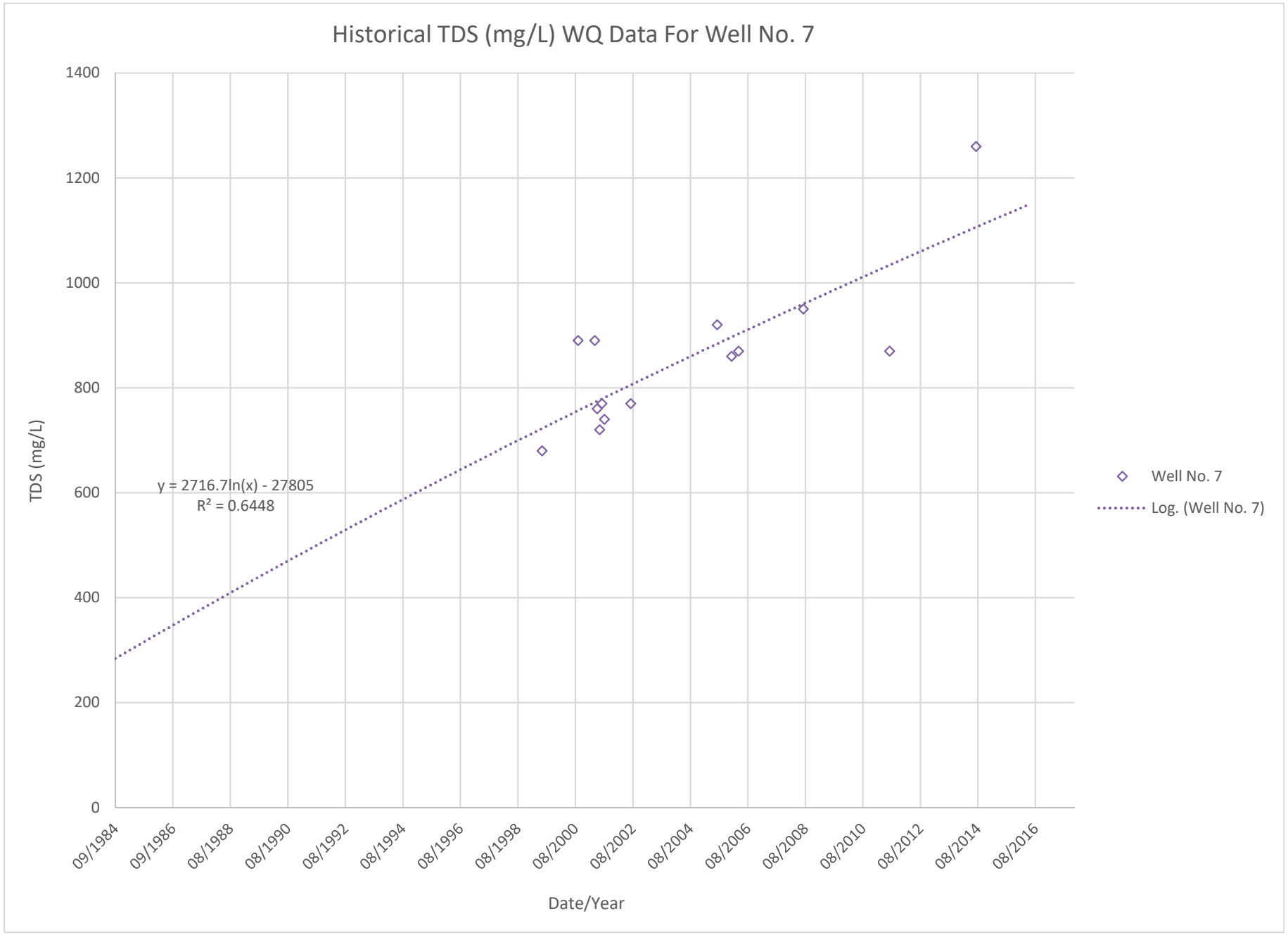
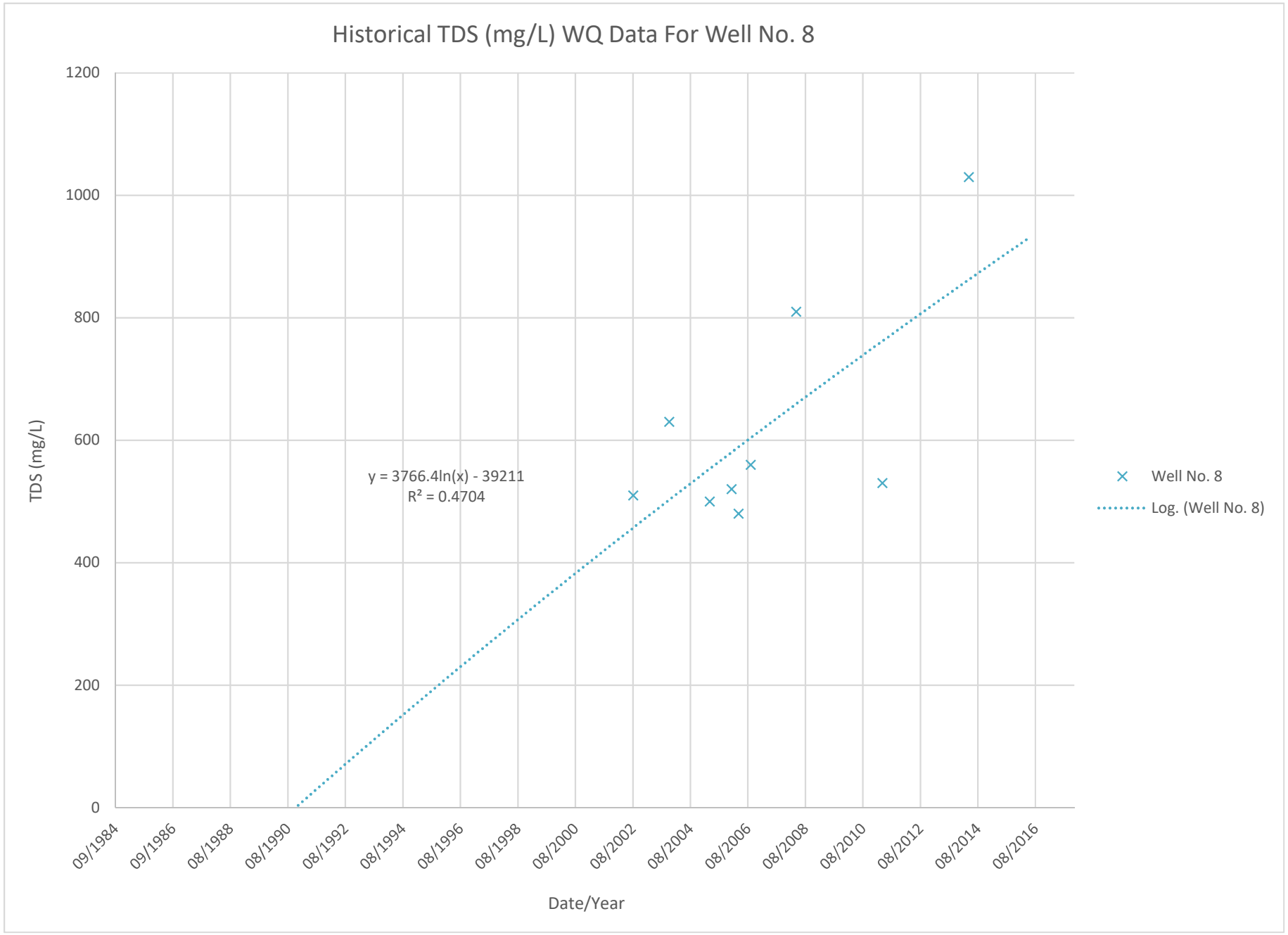
Appendix A - Water Quality and Cost Analysis Material

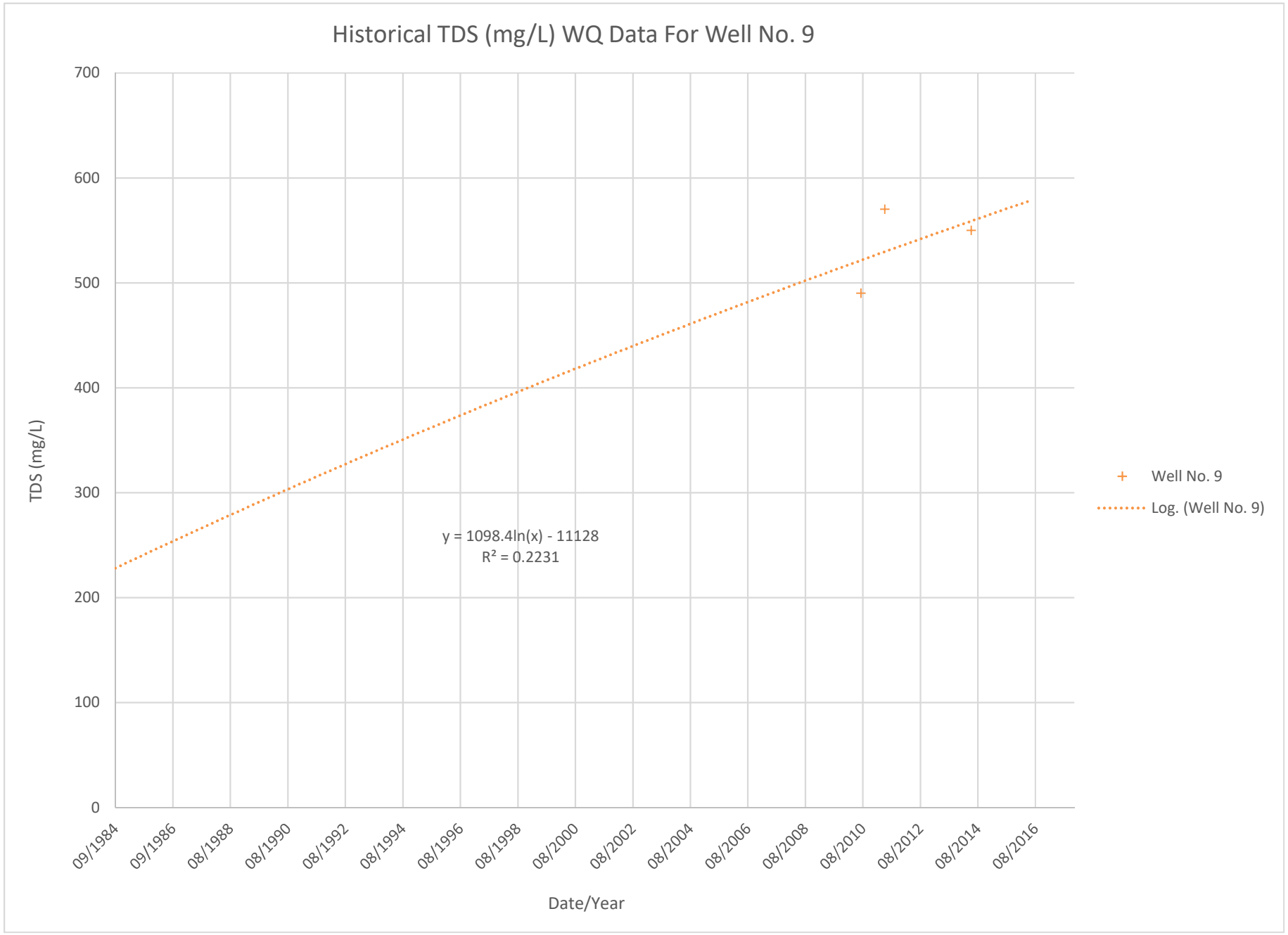

Historical TDS (mg/L) WQ Data For Well No. 2
TDS (mg/L)
1200
1000
800
600
400
200
0
y = -2.079ln(x) + 971.58
R² = 1E-05
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 2
Log. (Well No. 2)

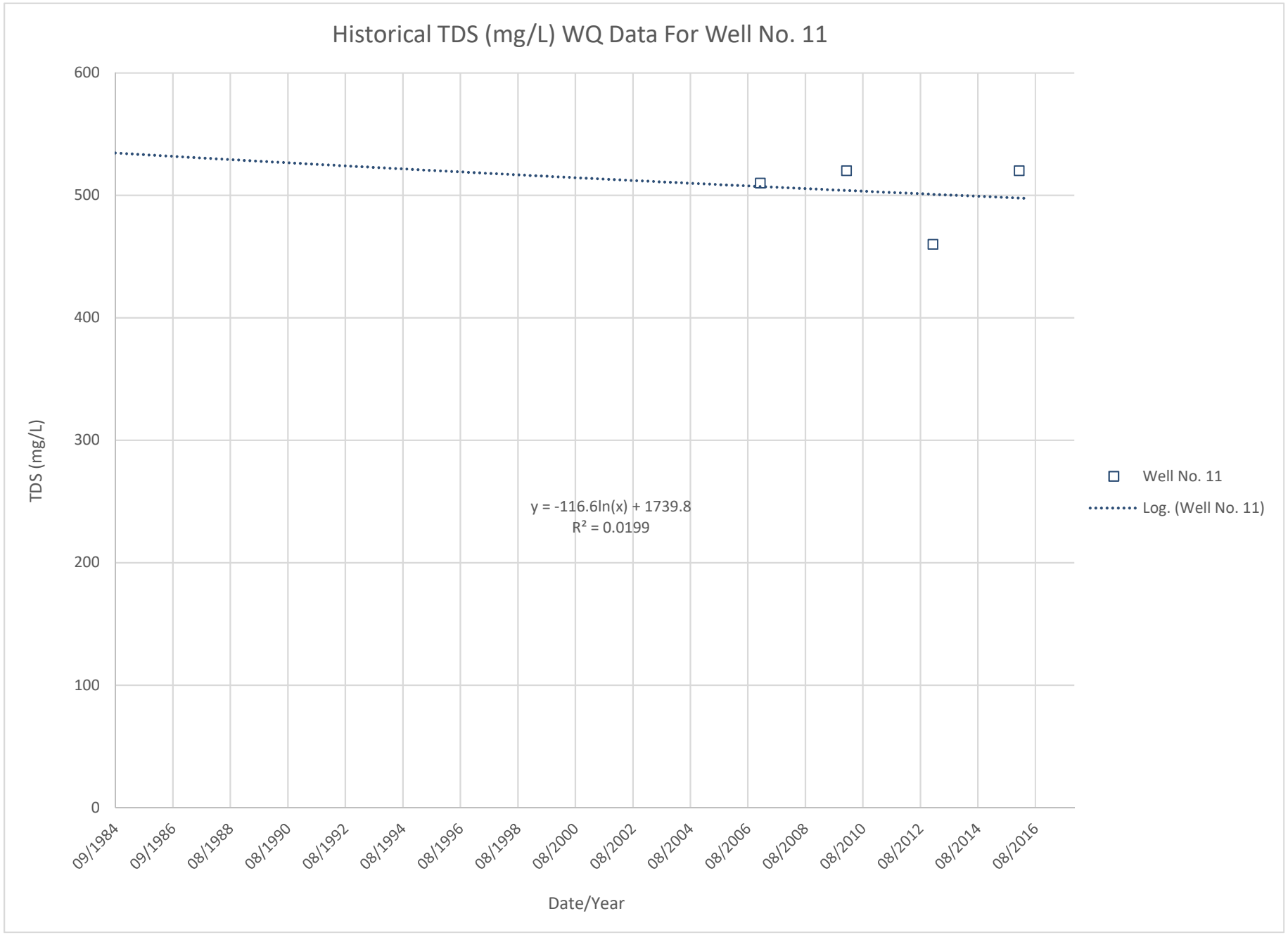

Historical TDS (mg/L) WQ Data For Well No. 5
TDS (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
y = 271.34ln(x) - 2035.5
R² = 0.1548
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 5
Log. (Well No. 5)

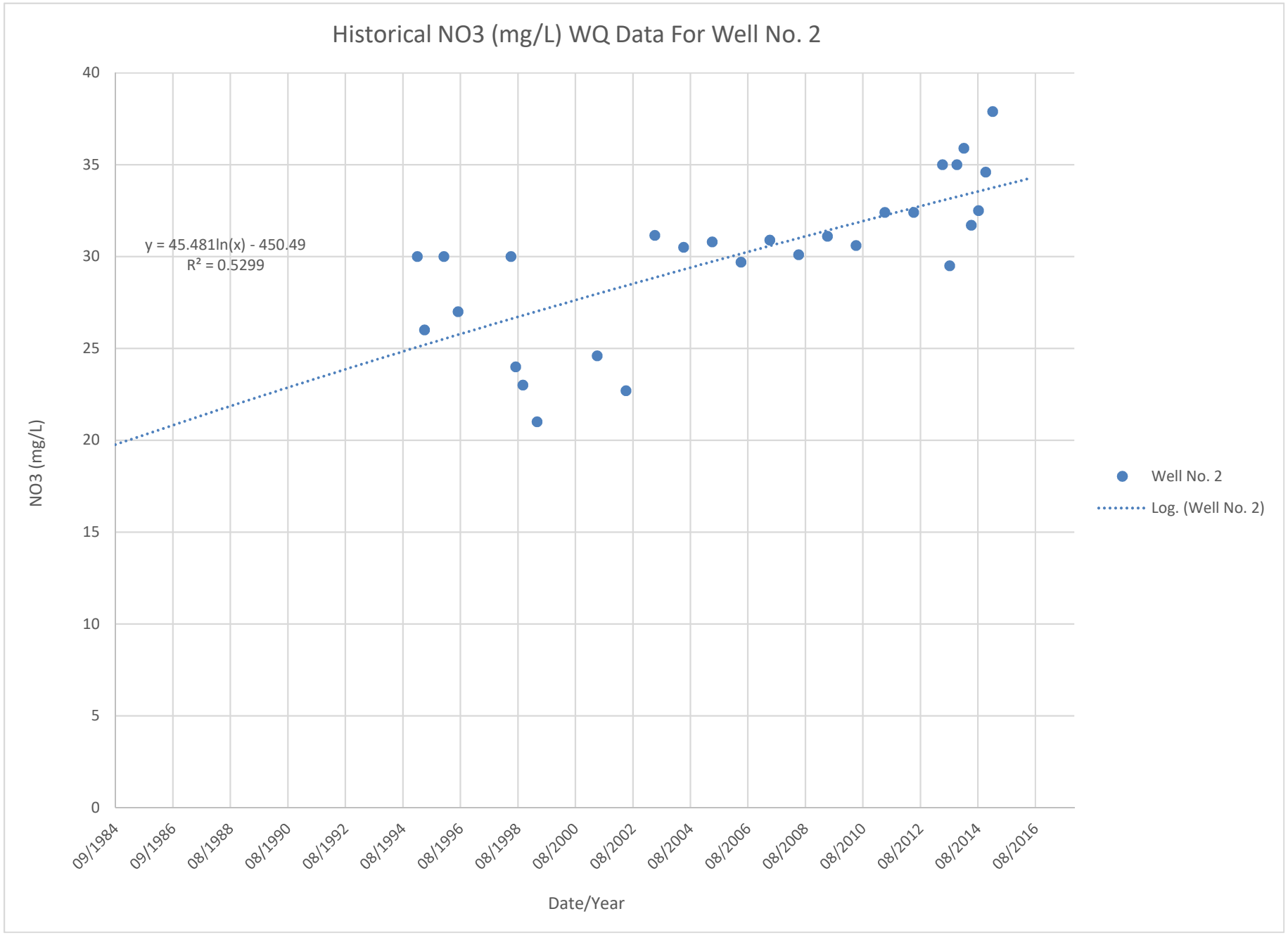

Historical TDS (mg/L) WQ Data For Well No. 6
TDS (mg/L)
1200
1000
800
600
400
200
0
y = 31.069ln(x) + 628.96
R² = 0.0026
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 6
Log. (Well No. 6)

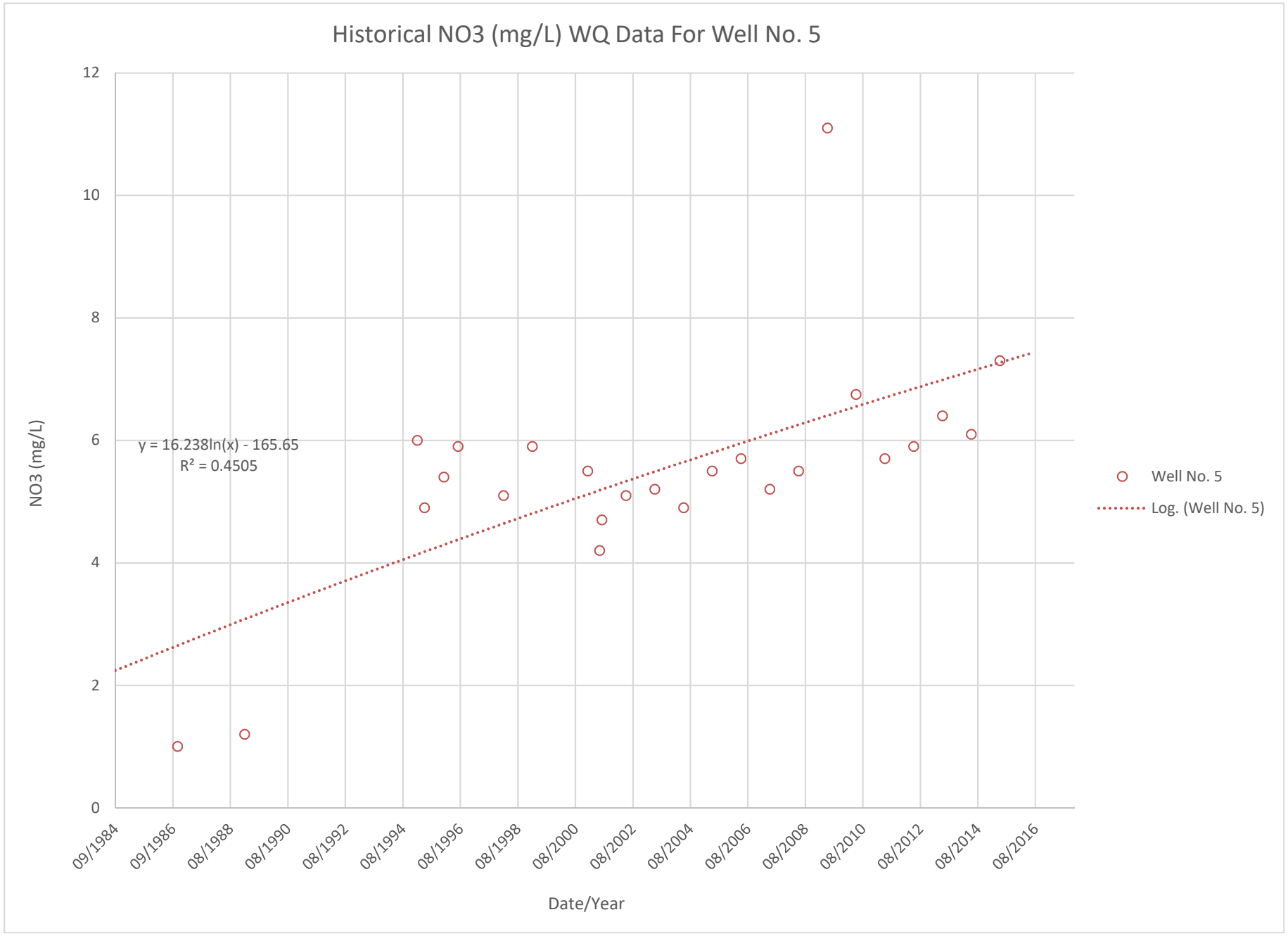

Historical TDS (mg/L) WQ Data For Well No. 7
TDS (mg/L)
1400
1200
1000
800
600
400
200
0
y = 2716.7ln(x) - 27805
R² = 0.6448
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 7
Log. (Well No. 7)

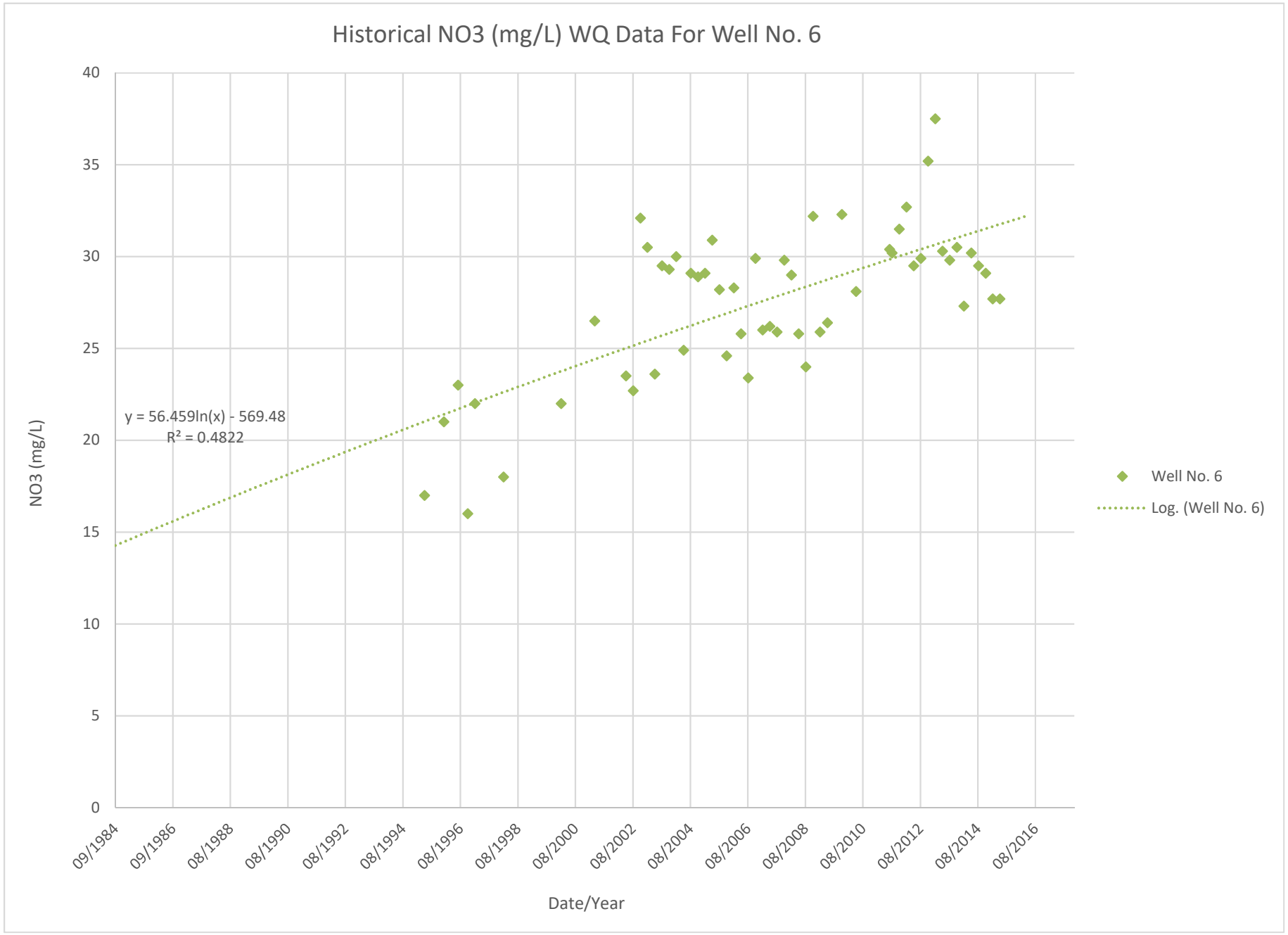

Historical TDS (mg/L) WQ Data For Well No. 8
TDS (mg/L)
1200
1000
800
600
400
200
0
y = 3766.4ln(x) - 39211
R² = 0.4704
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 8
Log. (Well No. 8)

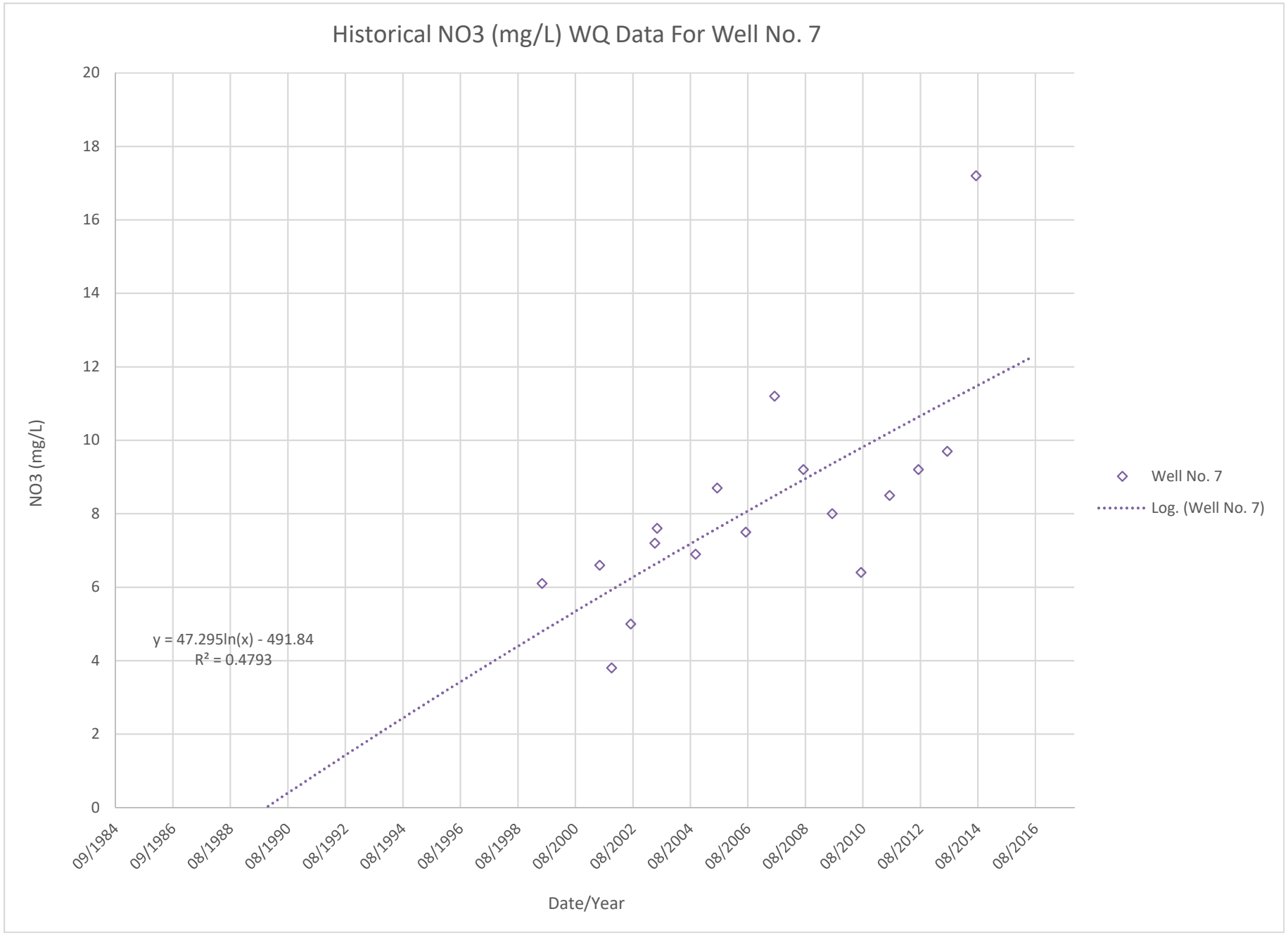

Historical TDS (mg/L) WQ Data For Well No. 9
TDS (mg/L)
700
600
500
400
300
200
100
0
y = 1098.4ln(x) - 11128
R² = 0.2231
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 9
Log. (Well No. 9)

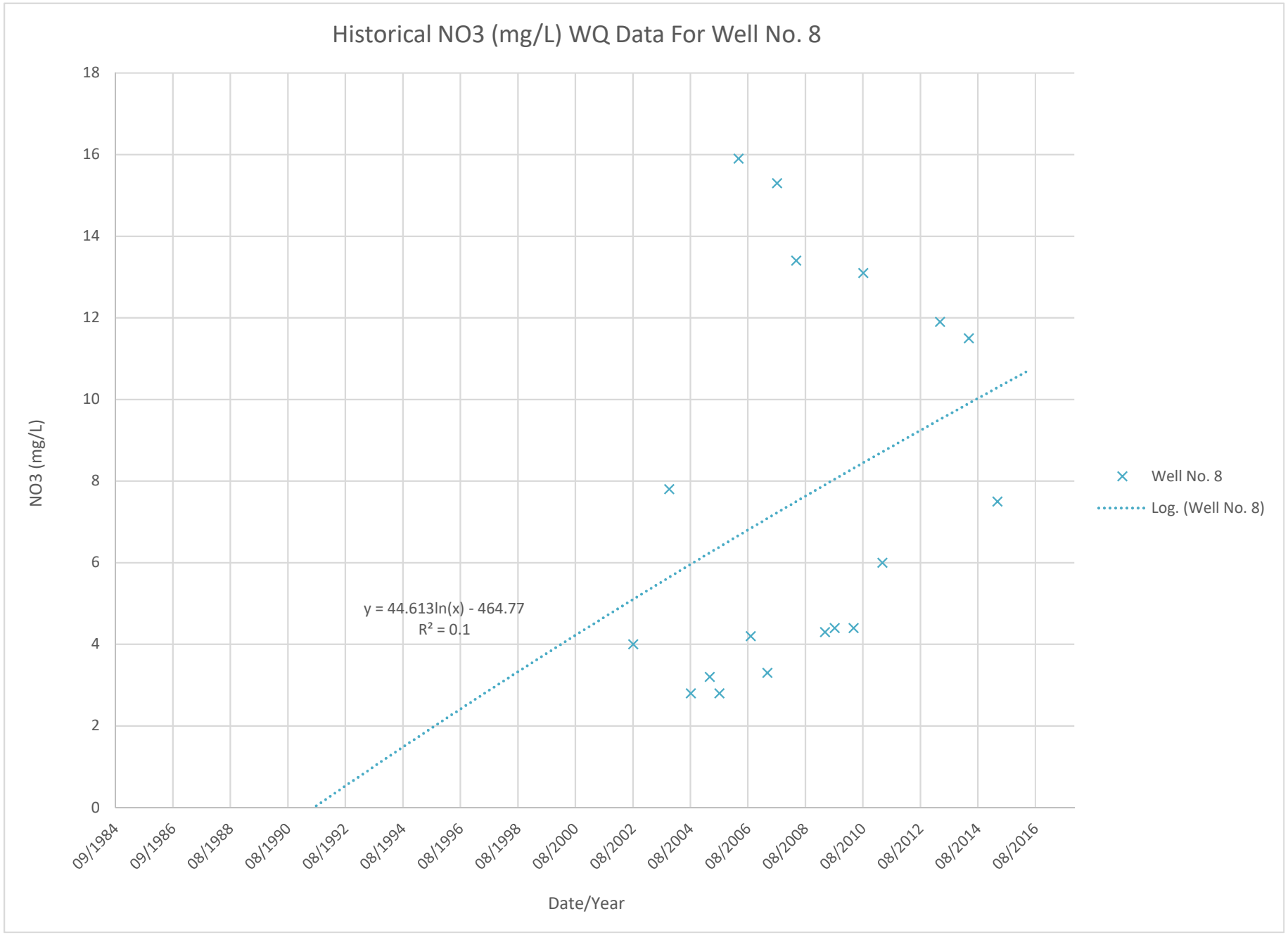

Historical TDS (mg/L) WQ Data For Well No. 11
600
500
400
300
200
100
0
TDS (mg/L)
y = -116.6ln(x) + 1739.8
R² = 0.0199
Well No. 11
Log. (Well No. 11)
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year

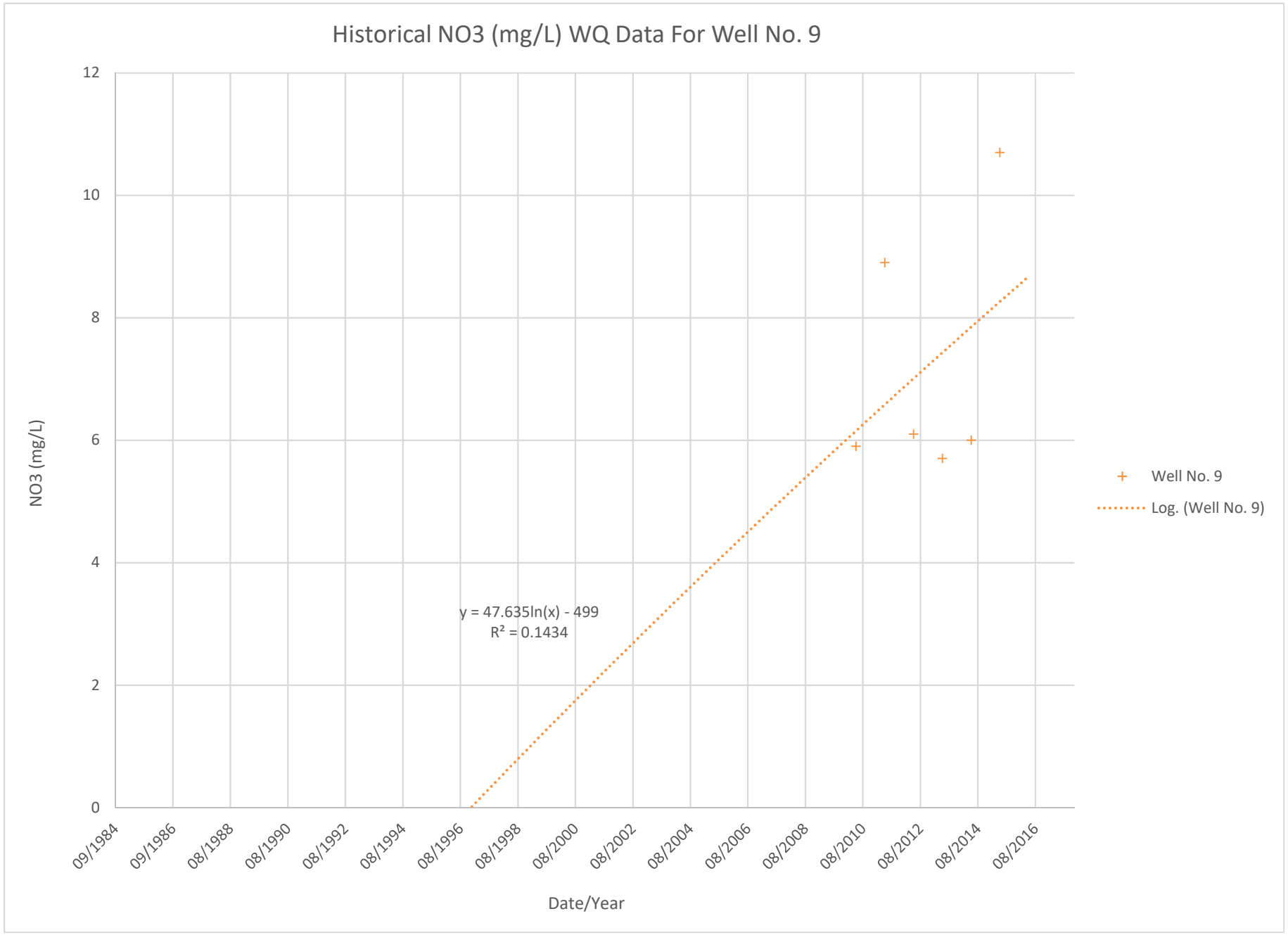

Historical NO3 (mg/L) WQ Data For Well No. 2
y = 45.481ln(x) - 450.49
R² = 0.5299
NO3 (mg/L)
Date/Year
0
5
10
15
20
25
30
35
40
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Well No. 2
Log. (Well No. 2)

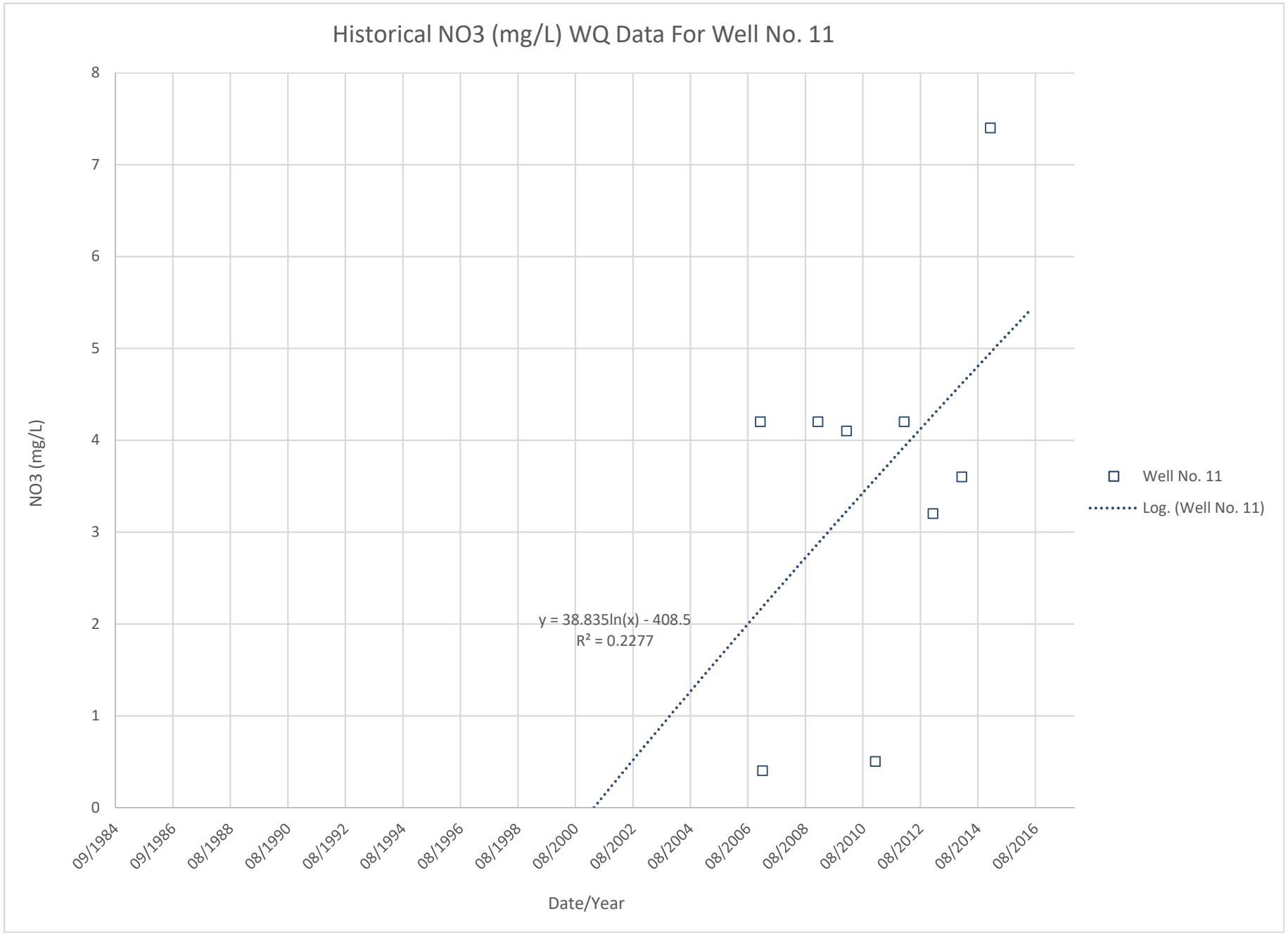

Historical NO3 (mg/L) WQ Data For Well No. 5
NO3 (mg/L)
Date/Year
y = 16.238ln(x) - 165.65
R² = 0.4505
Well No. 5
Log. (Well No. 5)
0
2
4
6
8
10
12
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016


Historical NO3 (mg/L) WQ Data For Well No. 6
NO3 (mg/L)
Date/Year
y = 56.459ln(x) - 569.48
R² = 0.4822
Well No. 6
Log. (Well No. 6)
0
5
10
15
20
25
30
35
40
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016


Historical NO3 (mg/L) WQ Data For Well No. 7
NO3 (mg/L)
Date/Year
y = 47.295ln(x) - 491.84
R² = 0.4793
Well No. 7
Log. (Well No. 7)
0
2
4
6
8
10
12
14
16
18
20
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016


Historical NO3 (mg/L) WQ Data For Well No. 8
NO3 (mg/L)
18
16
14
12
10
8
6
4
2
0
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
y = 44.613ln(x) - 464.77
R² = 0.1
Well No. 8
Log. (Well No. 8)


Historical NO3 (mg/L) WQ Data For Well No. 9
NO3 (mg/L)
12
10
8
6
4
2
0
y = 47.635ln(x) - 499
R² = 0.1434
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016
Date/Year
Well No. 9
Log. (Well No. 9)


Historical NO3 (mg/L) WQ Data For Well No. 11
NO3 (mg/L)
Date/Year
y = 38.835ln(x) - 408.5
R² = 0.2277
Well No. 11
Log. (Well No. 11)
0
1
2
3
4
5
6
7
8
09/1984
09/1986
08/1988
08/1990
08/1992
08/1994
08/1996
08/1998
08/2000
08/2002
08/2004
08/2006
08/2008
08/2010
08/2012
08/2014
08/2016

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- RCF Treatment (Landfill Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By: SSH
Check Date: 12/16/2016

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 561,000	
2 - Sitework	$ 250,000	
3 - Concrete	$ 33,000	
4 - Masonry	$ -	
5 - Metals	$ 20,000	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ 3,390,000	
12 - Furnishings	$ -	
13 - Special Construction	$ 223,000	
14 - Conveying Systems	$ -	
15 - Mechanical	$ 339,000	
16 - Electrical	$ 678,000	
17 - Instrumentation and Control	$ 678,000	
Raw Construction Subtotal	$ 6,172,000	
25% Construction Contingency	$ 1,543,000	
Construction Cost Subtotal	**$ 7,715,000**	
9% Tax on Materials	$ 348,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15% General Contractor Overhead and Profit	$ 1,158,000	
Estimated Total Construction Cost	**$ 9,221,000**	
15% Owner's Reserve for Change Orders	$ 1,384,000	
10% Environmental Documents and Permitting	$ 923,000	
15% Engineering Services (Design)	$ 1,384,000	
13% Construction Management	$ 1,199,000	
12% Engineering Services During Construction	$ 1,107,000	
Estimated Total Capital Cost	**$ 15,218,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 561,000**	
	Mobilization	10%		1	LS	$560,973	$ 561,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 33,000**	
	Treatment Equipment							
	Slab for Reduction Tank			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Aeration Chamber			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Backwash Water Storage			6	CY	$291	$ 2,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Lamella Clarifier			2	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Screw Press			3	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Solids Storage			33	CY	$291	$ 10,000	2016 Means HCCD 03 30 53.40 3590
	Chemical Storage and CIP							
	Chemical Storage Containment Area							
	Secondary Containment Walls			6	CY	$393	$ 2,000	2016 Means HCCD 03 30 53.40 4200
	CIP Area							
	Secondary Containment Walls			16	CY	$393	$ 6,000	2016 Means HCCD 03 30 53.40 4200
	Distribution Pumping							
	Product Water Tank			5	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Pump Station			7	CY	$291	$ 2,000	2016 Means HCCD 03 30 53.40 3590
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 20,000**	
	Chain Link Fence around perimeter			384	LF	$52	$ 20,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 3,389,243**	
	Treatment							
	Reduction, Aeration, Filtration			1	LS	$2,811,000	$ 2,811,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			1	LS	$228,000	$ 228,000	Vendor quotes
	Screw Press			1	LS	$217,500	$ 218,000	Vendor quotes
	Additional Pumping Requirements							
	Storage Tank Pump	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by at each site
	Distribution Water Pumps	50	hp	2	EA	$35,424	$ 70,848	1 duty, 1 standy by at each site
	Waste Collection Piping							
	Lateral Connection to Sewer	6	inch	50	ft	$150	$ 7,515	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 222,492**	
	Tanks							
	Ferrous Sulfate	1,000	gallons	1	EA	$1,802	$1,802	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sodium Hypochlorite	500	gallons	1	EA	$969	$969	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Lamella Clarifier Equalization Storage	6,000	gallons	1	EA	$9,410	$9,410	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Solids Storage Tank	3,000	gallons	2	EA	$6,368	$12,735	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Treated Water Tank	5,000	gallons	1	EA	$10,077	$10,077	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Building (CMU Construction)							
	Process and Electrical (assume 15' x 25')	1	EA	375	SF	$300	$112,500	Engineer's Estimate
	Chemical Storage and CIP (assume 10' x 25')	1	EA	250	SF	$300	$75,000	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 339,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$339,000	$ 339,000	10% of Division 11 Equipment
16 - Electrical							**$ 678,000**	
	Electrical Allowance	20%		1	LS	$678,000	$ 678,000	20% of Division 11 Equipment
17 - I&C							**$ 678,000**	
	I&C Allowance	20%		1	LS	$678,000	$ 678,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 68,000**	
Equipment Maintenance and Repair	2%	1	LS	$ 67,785	$ 68,000	2% of Equipment Cost
Power Costs					**$ 109,400**	
UF		41,161	kW	$0.16	$ 7,000	
UF CIP		72,131	kW	$0.16	$ 12,000	
UF Air Scour		169,386	kW	$0.16	$ 28,000	
Chemical Metering Pumps		45,708	kW	$0.16	$ 7,000	Assumed 7 chemical metering pumps
Water Storage Tank Pump		98,024	kW	$0.16	$ 16,000	
Distribution Water Pumps		238,199	kW	$0.16	$ 39,000	
Screw Press	993	2,483	kW	$0.16	$ 400.0	
Chemical Costs					**$ 19,400**	
Ferrous Sulfate		8,952	gal	$1.25	$ 11,000	
Sodium Hypochlorite		6,056	gal	$0.40	$ 2,400	CIP and Ferrous Sulfate Reduction
Citric Acid		791	gal	$6.04	$ 5,000	CIP
Polymer		266	lbs	$4.00	$ 1,000	
Disposal Costs					**$ 3,000**	
Dewatered Waste Disposal at 20% Solids (includes transportation)		21	Tons	$140	$ 3,000	

Labor COSTS			Quantity	Unit	Cost	Notes
					$ 315,000	
Initial 7 wells:	Full Time Equivalents		4	person(s)		
	Total Annual Hours per Year		8,320	Labor Hours		
	Average Labor Rate	$	38	$/hour	$ 315,000	
Every Well Install After first 7 wells:	Full Time Equivalents		0.5	person(s)		
	Total Annual Hours per Year		1,040	Labor Hours		
	Average Labor Rate	$	38	$/hour	$ 39,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
UF Membranes		5	76	Membranes	$1,850	$ 141,000	
Pump Replacement		10	100%	Pump Cost	$124,728	$ 125,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- WBA Treatment

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 373,000	
2 - Sitework		$ 250,000	
3 - Concrete		$ 9,000	
4 - Masonry		$ -	
5 - Metals		$ 13,000	
6 - Wood and Plastic		$ -	
7 - Moisture and Thermal Protection		$ -	
8 - Doors and Windows		$ -	
9 - Finishes		$ -	
10 - Specialties		$ -	
11 - Equipment		$ 2,293,000	
12 - Furnishings		$ -	
13 - Special Construction		$ 26,000	
14 - Conveying Systems		$ -	
15 - Mechanical		$ 229,000	
16 - Electrical		$ 458,000	
17 - Instrumentation and Control		$ 458,000	
	Raw Construction Subtotal	$ 4,109,000	
25%	Construction Contingency	$ 1,028,000	
	Construction Cost Subtotal	**$ 5,137,000**	
9%	Tax on Materials	$ 232,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15%	General Contractor Overhead and Profit	$ 771,000	
	Estimated Total Construction Cost	**$ 6,140,000**	
15%	Owner's Reserve for Change Orders	$ 921,000	
10%	Environmental Documents and Permitting	$ 614,000	
15%	Engineering Services (Design)	$ 921,000	
13%	Construction Management	$ 799,000	
12%	Engineering Services During Construction	$ 737,000	
	Estimated Total Capital Cost	**$ 10,132,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 373,000**	
	Mobilization	10%		1	LS	$373,426	$ 373,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 9,000**	
	Treatment Equipment							
	Slab for Catridge Filters			1	CY	$291	$ -	
	Slab for Resin Vessels			22	CY	$291	$ 6,000	
	Slab for Decarbonator			0	CY	$291	$ -	
	Distribution Pumping							
	Product Water Tank			5	CY	$291	$ 1,000	
	Slab for Pump Station			7	CY	$291	$ 2,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 13,000**	
	Chain Link Fence around perimeter			242	LF	$52	$ 13,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 2,292,183**	
	Treatment							
	Catridge Filters			1	LS	$39,000	$ 39,000	Vendor quotes
	WBA Resin Vessels and Regeneration Equipment			1	LS	$1,790,400	$ 1,791,000	Vendor quotes
	Decarbonator			1	LS	$87,000	$ 87,000	Vendor quotes
	Chemical Dosing							
	Carbon Dioxide Feed System			1	EA	$231,038	$ 231,038	
	Carbon Dioxide Feed Water Pump			2	EA	$9,709	$ 19,418	1 duty, 1 standy by at each site
	Additional Pumping Requirements							
	Storage Tank Pump	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by at each site
	Distribution Water Pumps	50	hp	2	EA	$35,424	$ 70,848	1 duty, 1 standy by at each site
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 25,077**	
	Tanks							
	Treated Water Tank	5,000	gallons	1	EA	$10,077	$10,077	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Building (CMU Construction)							
	Electrical (assume 5' x 10')	1	EA	50	SF	$300	$15,000	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 229,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$229,000	$ 229,000	10% of Division 11 Equipment
16 - Electrical							**$ 458,000**	
	Electrical Allowance	20%		1	LS	$458,000	$ 458,000	20% of Division 11 Equipment
17 - I&C							**$ 458,000**	
	I&C Allowance	20%		1	LS	$458,000	$ 458,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 109,000**	
Catridge Filters		2,704	Elements/year	$ 23	$ 63,000	changed weekly
Equipment Maintenance and Repair	2%	1	LS	$ 45,844	$ 46,000	2% of Equipment Cost
Power Costs					**$ 56,000**	
Water Storage Tank Pump		98,024	kW	$0.16	$ 16,000	
Distribution Water Pumps		238,199	kW	$0.16	$ 39,000	
Decarbonator Blower		4,901	kW	$0.16	$ 1,000	
Chemical Costs					**$ 103,000**	
Carbon Dioxide		526	per MG treated	$195.43	$ 103,000	
Labor					**$ 158,000**	
	Full Time Equivalents	2	person(s)			
	Total Annual Hours per Year	4,160	Labor Hours			
	Average Labor Rate	$ 38	$/hour		$ 158,000	
Every Well Install After first 7 wells:	Full Time Equivalents	0.5	person(s)			
	Total Annual Hours per Year	1,040	Labor Hours			
	Average Labor Rate	$ 38	$/hour		$ 39,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
Replacement Resin	1.8	848	CF	$524	$ 444,000	
Resin Disposal	1.8	8	Tons	$140	$ 1,000	
Pump Replacement	10	100%	Pump Cost	$124,728	$ 124,728	
Decarbonator Media	20	415	CF	$45	$ 19,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- SBA Treatment (Liquid Haul Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 343,000	
2 - Sitework		$ 250,000	
3 - Concrete		$ 11,000	
4 - Masonry		$ -	
5 - Metals		$ 33,000	
6 - Wood and Plastic		$ -	
7 - Moisture and Thermal Protection		$ -	
8 - Doors and Windows		$ -	
9 - Finishes		$ -	
10 - Specialties		$ -	
11 - Equipment		$ 1,311,000	
12 - Furnishings		$ -	
13 - Special Construction		$ 1,173,000	
14 - Conveying Systems		$ -	
15 - Mechanical		$ 131,000	
16 - Electrical		$ 262,000	
17 - Instrumentation and Control		$ 262,000	
	Raw Construction Subtotal	$ 3,776,000	
25%	Construction Contingency	$ 944,000	
	Construction Cost Subtotal	**$ 4,720,000**	
9%	Tax on Materials	$ 213,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15%	General Contractor Overhead and Profit	$ 708,000	
	Estimated Total Construction Cost	**$ 5,641,000**	
15%	Owner's Reserve for Change Orders	$ 847,000	
10%	Environmental Documents and Permitting	$ 565,000	
15%	Engineering Services (Design)	$ 847,000	
13%	Construction Management	$ 734,000	
12%	Engineering Services During Construction	$ 677,000	
	Estimated Total Capital Cost	**$ 9,311,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 343,000**	
	Mobilization	10%		1	LS	$343,224	$ 343,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 11,000**	
	Treatment Equipment							
	Slab for Catridge Filters			1	CY	$291	$ -	
	Slab for Resin Vessels and Regeneration Equipment			28	CY	$291	$ 8,000	
	Distribution Pumping							
	Product Water Tank			5	CY	$291	$ 1,000	
	Slab for Pump Station			7	CY	$291	$ 2,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 33,000**	
	Chain Link Fence around perimeter			643	LF	$52	$ 33,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 1,310,243**	
	Treatment							
	Catridge Filters			1	LS	$39,000	$ 39,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			1	LS	$1,138,650	$ 1,139,000	Vendor quotes
	Additional Pumping Requirements							
	Storage Tank Pump	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by at each site
	Distribution Water Pumps	50	hp	2	EA	$35,424	$ 70,848	1 duty, 1 standy by at each site
	Waste Collection Piping							
	Lateral Connection to Sewer	6	inch	50	ft	$150	$ 7,515	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 1,173,000**	
	Tanks							
	Distribution Water Tank with Storage for Nitrate Dilution	858,000	gallons	1	EA	$1	$ 1,158,000	Steel Tank
	Building (CMU Construction)							
	Electrical (assume 5' x 10')	1	EA	50	SF	$300	$15,000	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 131,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$131,000	$ 131,000	10% of Division 11 Equipment
16 - Electrical							**$ 262,000**	
	Electrical Allowance	20%		1	LS	$262,000	$ 262,000	20% of Division 11 Equipment
17 - I&C							**$ 262,000**	
	I&C Allowance	20%		1	LS	$262,000	$ 262,000	20% of Division 11 Equipment

ANNUAL O&M COSTS			Quantity	Unit		Value	Cost	Notes
Consumables							**$ 90,000**	
	Catridge Filters		2,704	Elements/year		$23	$ 63,000	changed weekly
	Equipment Maintenance and Repair	2%	1	LS	$	26,205	$ 27,000	2% of Equipment Cost 20% of Division 11 Equipment
Power Costs							**$ 56,000**	
	Water Storage Tank Pump		98,024	kW		$0.16	$ 16,000	
	Regeneration Pumps		4,357	kW		$0.16	$ 1,000	
	Distribution Water Pumps		238,199	kW		$0.16	$ 39,000	
Chemical Costs							**$ 212,000**	
	Regenerant Salt		2,357	ton		$90.00	$ 212,000	regeneration estimated at every 10.5 hours of operation
Disposal Costs							**$ 1,061,000**	
	Regeneration Brine Disposal Fee		4,993,200	gallons		$0.05	$ 250,000	
	Regeneration Brine Hauling Fee		4,993,200	gallons		$0.16	$ 811,000	
Labor							**$ 236,000**	
		Full Time Equivalents	3	person(s)				
		Total Annual Hours per Year	6,240	Labor Hours				
		Average Labor Rate	$ 38	$/hour			$ 236,000	
	Every Well Install After first 7 wells:	Full Time Equivalents	0.5	person(s)				
		Total Annual Hours per Year	1,040	Labor Hours				
		Average Labor Rate	$ 38	$/hour			$ 39,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
	Resin Replacement	7	424	CF	$203	$ 85,860	
	Resin Disposal Cost as Solid Waste	7	8	Tons	$43	$ 360	
	Pump Replacement	10	100%	Pump Cost	$124,728	$ 124,728	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- Reverse Osmosis Treatment

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 439,000	
2 - Sitework	$ 250,000	
3 - Concrete	$ 17,000	
4 - Masonry	$ -	
5 - Metals	$ 48,000	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ 2,474,000	
12 - Furnishings	$ -	
13 - Special Construction	$ 364,000	
14 - Conveying Systems	$ -	
15 - Mechanical	$ 247,000	
16 - Electrical	$ 495,000	
17 - Instrumentation and Control	$ 495,000	
Raw Construction Subtotal	$ 4,829,000	
25% Construction Contingency	$ 1,208,000	
Construction Cost Subtotal	**$ 6,037,000**	
9% Tax on Materials	$ 272,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15% General Contractor Overhead and Profit	$ 906,000	
Estimated Total Construction Cost	**$ 7,215,000**	
15% Owner's Reserve for Change Orders	$ 1,083,000	
10% Environmental Documents and Permitting	$ 722,000	
15% Engineering Services (Design)	$ 1,083,000	
13% Construction Management	$ 938,000	
12% Engineering Services During Construction	$ 866,000	
Estimated Total Capital Cost	**$ 11,907,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 439,000**	
	Mobilization	10%		1	LS	$438,862	$ 439,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 17,000**	
	Treatment Equipment							
	Slab for Lamella Clarifier			2	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Spent Backwash Water Storage			14	CY	$291	$ 4,000	
	Slab for Interprocess Tank			12	CY	$291	$ 3,000	
	Slab for Transfer Pumps			7	CY	$291	$ 2,000	
	Chemical Storage							
	Chemical Storage Containment Area							
	Walls			9	CY	$393	$ 4,000	2016 Means HCCD 03 30 53.40 4200
	Distribution Pumping							
	Slab for Effluent Water Pump Station			7	CY	$291	$ 2,000	
	Slab for Effluent Water Tank			5	CY	$291	$ 1,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 47,100**	
	Chain Link Fence around perimeter			906	LF	$52	$ 47,100	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 2,473,515**	
	Treatment							
	Microfiltration Treatment			1	LS	$900,000	$ 900,000	Vendor quotes
	Lamella Clarifier			1	LS	$228,000	$ 228,000	Vendor quotes
	Reverse Osmosis			1	LS	$1,110,000	$ 1,110,000	Vendor quotes; Package includes feed pumps, membrane system, CIP system
	Additional Pumping Requirements							
	RO Transfer Pumps	15	hp	2	EA	$26,940	$ 54,000	
	Water Storage Pump	15	hp	2	EA	$26,940	$ 54,000	
	Distribution Water Pumps	40	hp	2	EA	$33,000	$ 66,000	
	Waste Pumps	15	hp	2	EA	$26,940	$ 54,000	
	Distribution & Collection Piping							
	Lateral Connection to Sewer	6	inch	50	FT	$150	$ 7,515	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 364,000**	
	Tanks							
	Inter-Process Tank	35,000	gallons	1	EA	$2	$ 55,000	
	Sodium Bisulfite Tank	1,000	gallons	0	EA	$1,802	$ -	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sodium Hydroxide Tank	1,200	gallons	1	EA	$1,802	$ 2,000	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sulfuric Acid Tank	1,000	gallons	0	EA	$1,802	$ -	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Antiscalant Tank	150	gallons	1	EA	$300	$ 1,000	
	Treated Water Tank	1,000	gallons	1	EA	$1,802	$ 2,000	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Lamella Clarifier Equalization Storage	50,000	gallons	1	EA	$2	$ 79,000	
	Building (CMU Construction)							
	Process and Electrical (assume 15' x 25')	1	EA	375	SF	$300	$112,500	Engineer's Estimate
	Chemical Storage and CIP (assume 15' x 25')	1	EA	375	SF	$300	$112,500	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 247,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$247,000	$ 247,000	10% of Division 11 Equipment
16 - Electrical							**$ 495,000**	
	Electrical Allowance	20%		1	LS	$495,000	$ 495,000	20% of Division 11 Equipment, markup includes building
17 - I&C							**$ 495,000**	
	I&C Allowance	20%		1	LS	$495,000	$ 495,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 50,000**	
	Catridge Filters	1352	Elements/year	23.26	$ 31,000	2 week interval change out
	Equipment Maintenance and Repair 2%	1	LS	$ 49,470	$ 50,000	2% of Equipment Cost
Power Costs					**$ 222,700**	
	MF CIP	10,929	kW	$0.16	$ 2,000	
	MF Air Scour	178,226	kW	$0.16	$ 29,000	
	RO Pumps	809,035	kW	$0.16	$ 131,000	
	RO interstage pump	20,301	kW	$0.16	$ 3,000	
	RO CIP pumps	10,001	kW	$0.16	$ 2,000	
	RO transfer Pump	20,301	kW	$0.16	$ 3,000	
	Water Storage Tank Pump	71,489	kW	$0.16	$ 12,000	
	Chemical Metering Pumps	12,862	kW	$0.16	$ 2,000	
	Distribution Water Pump	238,199	kW	$0.16	$ 38,700	
Chemical Costs					**$ 41,000**	
	Sodium Bisulfite		gal	$1.32	$ -	
	Citric Acid	832	gal	$6.04	$ 5,000	CIP and Ferrous Sulfate Reduction
	Sodium Hydroxide	14,400	gal	$2.50	$ 36,000	CIP
	Antiscalant	1,600	gal	$16.82	$ 27,000	

Labor COSTS		Quantity	Unit	Cost	Notes
				$ 236,000	
	Full Time Equivalents	3	person(s)		
	Total Annual Hours per Year	6,240	Labor Hours		
	Average Labor Rate $	38	$/hour	$ 236,000	
Every Well Install After first 7 wells:	Full Time Equivalents	0.5	person(s)		
	Total Annual Hours per Year	1,040	Labor Hours		
	Average Labor Rate $	38	$/hour	$ 39,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
UF Membranes	3	76	Membranes	$1,850	$ 141,000	
RO Membrances	5	231	Membranes	$650	$ 150,000	
Pump Replacement	10	100%	Pump Cost	$228,000	$ 228,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized - RCF Treatment (Landfill Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 4,743,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 264,000	
4 - Masonry			$ -	
5 - Metals			$ 78,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 22,900,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 10,236,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 2,290,000	
16 - Electrical			$ 4,580,000	
17 - Instrumentation and Control			$ 4,580,000	
		Raw Construction Subtotal	$ 52,171,000	
	25%	Construction Contingency	$ 13,043,000	
		Construction Cost Subtotal	**$ 65,214,000**	
	9%	Tax on Materials	$ 2,935,000	Percentage of materials costs (materials cost estimate as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 9,783,000	
		Estimated Total Construction Cost	**$ 77,932,000**	
	15%	Owner's Reserve for Change Orders	$ 11,690,000	
	10%	Environmental Documents and Permitting	$ 7,794,000	
	15%	Engineering Services (Design)	$ 11,690,000	
	13%	Construction Management	$ 10,132,000	
	12%	Engineering Services During Construction	$ 9,352,000	
		Estimated Total Capital Cost	**$ 128,590,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 4,743,000**	
	Mobilization	10%		1	LS	$4,742,726	$ 4,743,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 264,000**	
	Treatment Equipment							
	Slab for Reduction and Oxidation/Coagulation Tanks			249	CY	$291	$ 72,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Backwash Water Storage			51	CY	$291	$ 15,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Spent Backwash Water Storage			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Lamella Clarifier			60	CY	$291	$ 17,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Screw Press			139	CY	$291	$ 40,000	2016 Means HCCD 03 30 53.40 3590
	Chemical Storage							
	Secondary Containment Walls			17	CY	$393	$ 7,000	2016 Means HCCD 03 30 53.40 4200
	CIP Area							
	Secondary Containment Walls			10	CY	$393	$ 4,000	2016 Means HCCD 03 30 53.40 4200
	Other Areas							
	Slab for Bypass Pump Station			11	CY	$291	$ 3,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Solids Storage			33	CY	$291	$ 10,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Transformer			37	CY	$291	$ 11,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Switchgear			19	CY	$291	$ 6,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Influent Water Pump Station Slab			15	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Effluent Water Tank			200	CY	$291	$ 58,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Effluent Water Pump Station Slab			15	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 78,000**	
	Chain Link Fence around perimeter			1,508	LF	$52	$ 78,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 22,899,260**	
	Treatment							
	Reduction, Aeration, Filtration			1	LS	$16,866,000	$ 16,866,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			1	LS	$1,197,000	$ 1,197,000	Vendor quotes
	Screw Press			1	LS	$217,500	$ 218,000	Vendor quotes
	Additional Pumping Requirements							
	Influent Process Pumps	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	1 duty, 1 standy by at each site
	Water Storage Tank Pump	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	1 duty, 1 standy by at each site
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431 ft		$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204 ft		$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194 ft		$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559 ft		$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580 ft		$601	$ 348,696	
	Distribution & Collection Piping							
	Sewer Lateral Connection	6	inch	100 ft		$150	$ 15,030	
	Distribution Lateral Connection	30	inch	1,000 ft		$752	$ 751,500	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 10,236,000**	
	Buildings (CMU Construction)							
	Process Building (Est. 140' x 180'; incl. equip. storage, elec. room, and staff facilities)			25,200	SF	$300	$ 7,560,000	
	Chemical Storage (15' x 30')			450	SF	$300	$ 135,000	
	CIP (Est. 45' x 35')			1575	SF	$300	$ 473,000	
	Tanks							
	Ferrous Sulfate	10,500	gallons	1	EA	$16,017	$ 17,000	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Sodium Hypochlorite	3,500	gallons	1	EA	$6,368	$ 7,000	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Lamella Clarifier Equalization Storage	500,000	gallons	1	EA	$2	$ 785,000	
	Sludge Storage Tank	6,500	gallons	1	EA	$10,124	$ 11,000	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Distribution Water Tank	809,000	gallons	1	EA	$1	$ 1,092,000	
	Influent Water Tank	70,000	gallons	1	EA	$2	$ 156,000	
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 2,290,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$2,290,000	$ 2,290,000	10% of Division 11 Equipment
16 - Electrical							**$ 4,580,000**	
	Electrical Allowance	20%		1	LS	$4,580,000	$ 4,580,000	20% of Division 11 Equipment
17 - I&C							**$ 4,580,000**	
	I&C Allowance	20%		1	LS	$4,580,000	$ 4,580,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 458,000**	
	Equipment Maintenance and Repair 2%	1	LS	$ 457,985	$ 458,000	2% of Equipment Cost
Power Costs					**$ 1,048,000**	
	Process Pumps	471,824	kW	$0.16	$ 77,000	
	Bypass Water Pumps	143,116	kW	$0.16	$ 23,000	
	UF Feed Pumps	2,050,582	kW	$0.16	$ 333,000	
	UF CIP	72,131	kW	$0.16	$ 12,000	
	UF Air Scour	1,176,293	kW	$0.16	$ 191,000	
	Screw Press	2,296	kW	$0.16	$ -	
	Water Storage Tank Pump	471,824	kW	$0.16	$ 77,000	
	Chemical Metering Pumps	13,059	kW	$0.16	$ 2,000	Assumed 2 chemical metering pumps
	Distribution Water Pumps	2,048,511	kW	$0.16	$ 333,000	
Chemical Costs					**$ 155,000**	
	Ferrous Sulfate	78,000	gal	$1.25	$ 98,000	
	CIP Caustic (Sodium Hypochlorite)	42,053	gal	$0.40	$ 17,000	
	CIP Acid (Citric Acid)	5,492	gal	$6.04	$ 33,000	
	Polymer	1,683	lbs	$4.00	$ 7,000	
Disposal Costs					**$ 19,000**	
	Dewatered Waste Disposal at 20% Solids (includes transportation)	137	Tons	$140	$ 19,000	
Labor					**$ 315,000**	
	Full Time Equivalents	4	person(s)			
	Total Annual Hours per Year	8,320	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 315,000	
				TOTAL ANNUAL O&M COSTS	$ 1,995,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
	MF Membranes	3	450	Membranes	$1,850	$ 833,000	
	Pump Replacement	10	100%	Pump Cost	$472,084	$ 472,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized - RCF Treatment Expansion (Landfill Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 1,565,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 10,436,000	
13 - Special Construction			$ -	
15 - Mechanical			$ 1,044,000	
16 - Electrical			$ 2,087,000	
17 - Instrumentation and Control			$ 2,087,000	
		Raw Construction Subtotal	$ 17,219,000	
	25%	Construction Contingency	$ 4,305,000	
		Construction Cost Subtotal	**$ 21,524,000**	
	9%	Tax on Materials	$ 969,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 3,229,000	
		Estimated Total Construction Cost	**$ 25,722,000**	
	15%	Owner's Reserve for Change Orders	$ 3,859,000	
	10%	Environmental Documents and Permitting	$ 2,573,000	
	15%	Engineering Services (Design)	$ 3,859,000	
	13%	Construction Management	$ 3,344,000	
	12%	Engineering Services During Construction	$ 3,087,000	
		Estimated Total Capital Cost	**$ 42,444,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,565,000**	
	Mobilization	10%		1	LS	$1,565,351	$ 1,565,000	10% of Divisions 2-17
2 - Sitework							**$ -**	
3 - Concrete							**$ -**	
5 - Metals							**$ -**	
9 - Finishes							**$ -**	
11 - Equipment							**$ 10,435,513**	
	Treatment							
	Reduction, Coagulation, Filtration			0.6	LS	$16,866,000	$ 9,591,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			0.6	LS	$1,197,000	$ 681,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pump	40	hp	1	EA	$33,000	$ 33,000	1 duty, 1 standy by at each site
	Bypass Water Pump	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Water Storage Tank Pump	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Distribution Water Pump	200	hp	1	EA	$71,786	$ 71,786	1 duty, 1 standy by at each site
13 - Special Construction							**$ -**	
15 - Mechanical							**$ 1,044,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,044,000	$ 1,044,000	10% of Division 11 Equipment
16 - Electrical							**$ 2,087,000**	
	Electrical Allowance	20%		1	LS	$2,087,000	$ 2,087,000	20% of Division 11 Equipment
17 - I&C							**$ 2,087,000**	
	I&C Allowance	20%		1	LS	$2,087,000	$ 2,087,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 667,000**	
	Equipment Maintenance and Repair 2%	1	LS	$ 666,710	$ 667,000	2% of Equipment Cost
Power Costs					**$ 1,642,000**	
	Process Pumps	740,109	kW	$0.16	$ 120,000	
	Bypass Water Pumps	224,493	kW	$0.16	$ 36,000	
	UF Feed Pumps	3,216,568	kW	$0.16	$ 522,000	
	UF CIP	113,146	kW	$0.16	$ 18,000	
	UF Air Scour	1,845,147	kW	$0.16	$ 300,000	
	Screw Press	3,602	kW	$0.16	$ 1,000	
	Water Storage Tank Pump	740,109	kW	$0.16	$ 120,000	
	Chemical Metering Pumps	20,485	kW	$0.16	$ 3,000	
	Distribution Water Pumps	3,213,319	kW	$0.16	$ 522,000	
Chemical Costs					**$ 242,000**	
	Ferrous Sulfate	122,352	gal	$1.25	$ 153,000	
	CIP Caustic (Sodium Hypochlorite)	65,964	gal	$0.40	$ 26,000	
	CIP Acid (Citric Acid)	8,615	gal	$6.04	$ 52,000	
	Polymer	2,639	lbs	$4.00	$ 11,000	
Disposal Costs					**$ 30,000**	
	Dewatered Waste Disposal at 20% Solids	215	CY	$140	$ 30,000	
Labor					**$ 315,000**	
	Full Time Equivalents	4	person(s)			
	Total Annual Hours per Year	8,320	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 315,000	
				TOTAL ANNUAL O&M COSTS	$ 2,896,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						**$ 1,411,000**	
	MF Membranes	3	706	Membranes	$1,850	$ 1,306,000	
	Pump Replacement	10	100%	Pump Cost	$104,786	$ 105,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- WBA Treatment

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 2,947,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 150,000	
4 - Masonry			$ -	
5 - Metals			$ 79,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 13,232,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 1,248,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 1,323,000	
16 - Electrical			$ 3,970,000	
17 - Instrumentation and Control			$ 2,646,000	
		Raw Construction Subtotal	$ 28,095,000	
	25%	Construction Contingency	$ 7,024,000	
		Construction Cost Subtotal	**$ 35,119,000**	
	9%	Tax on Materials	$ 1,581,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 5,268,000	
		Estimated Total Construction Cost	**$ 41,968,000**	
	15%	Owner's Reserve for Change Orders	$ 6,296,000	
	10%	Environmental Documents and Permitting	$ 4,197,000	
	15%	Engineering Services (Design)	$ 6,296,000	
	13%	Construction Management	$ 5,456,000	
	12%	Engineering Services During Construction	$ 5,037,000	
		Estimated Total Capital Cost	**$ 69,250,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 2,947,000**	
	Mobilization	10%		1	LS	$2,947,378	$ 2,947,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 150,000**	
	Treatment Equipment							
	Slab for Catridge Filters			29	CY	$291	$ 8,000	
	Slab for Resin Vessels and Regeneration Equipment			28	CY	$291	$ 8,000	
	Slab for Decarbonator			69	CY	$291	$ 20,000	
	Chemical Storage Area							
	Wall			10	CY	$393	$ 4,000	
	Distribution Pumping							
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	
	Slab for Influent Water Pumps			47	CY	$291	$ 14,000	
	Slab for Bypass Water Pumps			26	CY	$291	$ 8,000	
	Slab for Effluent Water Tank			200	CY	$291	$ 58,000	
	Slab for Transformer			37	CY	$291	$ 11,000	
	Slab for Switch Gear			19	CY	$291	$ 6,000	
	Slab for Pump Station			15	CY	$291	$ 4,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 79,000**	
	Chain Link Fence around perimeter			1,336	LF	$52	$ 69,000	
	Misc. Metals Allowance			1	LS	$10,000	$ 10,000	Engineer's Estimate
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
	Coating Allowance				LS	$15,000	$ -	Engineer's Estimate
10 - Specialties							**$ -**	
11 - Equipment							**$ 13,231,784**	
	Treatment							
	Catridge Filters			2	EA	$90,000	$ 180,000	Vendor quotes
	WBA Resin Vessels and Regeneration Equipment			1	LS	$6,791,700	$ 6,792,000	Vendor quotes
	Decarbonator			1	LS	$337,500	$ 338,000	Vendor quotes
	Chemical Dosing							
	Carbon Dioxide Feed System			4	EA	$308,050	$ 1,232,201	
	Carbon Dioxide Feed Water Pump			7	EA	$9,709	$ 67,962	
	Additional Pumping Requirements							
	Process Pumps	90	hp	3	EA	$45,120	$ 135,361	2 duty, 1 standy by
	Water Storage Pump	40	hp	2	EA	$33,000	$ 66,000	1 duty, 1 standy by
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	2 duty, 1 standy by
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	2 duty, 1 standy by
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431 ft		$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204 ft		$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194 ft		$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559 ft		$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580 ft		$601	$ 348,696	
	Distribution & Collection Piping							
	Sewer Lateral Connection	6	inch	100 ft		$150	$ 15,030	
	Lateral Connection	30	inch	1,000 ft		$752	$ 751,500	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 1,248,000**	
	Process Building							
	Process Building (Est. 240' x 140'; incl. equip. storage, elec. room, and staff facilities)			14,000	SF	$300	$ 4,200,000	
	Chemical Storage (105' x 40')			420	SF	$300	$ 126,000	
	Tanks							
	Distribution Water Tank	809,000	gallons	1	EA	$1	$ 1,092,000	
	Influent Water Tank	70,000	gallons	1	EA	$2	$ 156,000	
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 1,323,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,323,000	$ 1,323,000	10% of Division 11 Equipment
16 - Electrical							**$ 3,970,000**	
	Electrical Allowance	30%		1	LS	$3,970,000	$ 3,970,000	30% of Division 11 Equipment
17 - I&C							**$ 2,646,000**	
	I&C Allowance	20%		1	LS	$2,646,000	$ 2,646,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 691,000**	
Catridge Filters		18,304	Elements/year	$23	$ 426,000	changed weekly
Equipment Maintenance and Repair	2%	1	LS	$ 264,636	$ 265,000	2% of Equipment Cost
Power Costs					**$ 620,000**	
Influent Feed Pumps		1,100,487	kW	$0.16	$ 179,000	
Bypass Water Pumps		143,116	kW	$0.16	$ 23,000	
Water Storage Tank Pump		471,824	kW	$0.16	$ 77,000	
Distribution Water Pumps		2,048,511	kW	$0.16	$ 333,000	
Decarbonator Blower		48,992	kW	$0.16	$ 8,000	
Chemical Costs					**$ 678,000**	
Carbon Dioxide		3,469	per MG treated	$195.43	$ 678,000	
Labor					**$ 158,000**	
	Full Time Equivalents	2	person(s)			
	Total Annual Hours per Year	4,160	Labor Hours			
	Average Labor Rate	$ 38	$/hour		$ 158,000	
				TOTAL ANNUAL O&M COSTS	$ 2,147,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
Replacement Resin	1.8	3794	cubic feet	$524	$ 1,986,000	
Resin Disposal	1.8	76	Tons	$140	$ 11,000	
Pump Replacement	10	100%	Pump Cost	$475,446	$ 475,000	
Decarbonator Media	20	2880	CF	$45	$ 130,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- WBA Treatment Expansion

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 1,544,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 9,653,000	
13 - Special Construction			$ -	
15 - Mechanical			$ 965,000	
16 - Electrical			$ 2,896,000	
17 - Instrumentation and Control			$ 1,930,000	
		Raw Construction Subtotal	$ 16,988,000	
25%		Construction Contingency	$ 4,247,000	
		Construction Cost Subtotal	**$ 21,235,000**	
9%		Tax on Materials	$ 956,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15%		General Contractor Overhead and Profit	$ 3,186,000	
		Estimated Total Construction Cost	**$ 25,377,000**	
15%		Owner's Reserve for Change Orders	$ 3,807,000	
10%		Environmental Documents and Permitting	$ 2,538,000	
15%		Engineering Services (Design)	$ 3,807,000	
13%		Construction Management	$ 3,300,000	
12%		Engineering Services During Construction	$ 3,046,000	
		Estimated Total Capital Cost	**$ 41,875,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,544,000**	
	Mobilization	10%		1	LS	$1,544,321	$ 1,544,000	10% of Divisions 2-17
2 - Sitework							**$ -**	
3 - Concrete							**$ -**	
5 - Metals							**$ -**	
9 - Finishes							**$ -**	
11 - Equipment							**$ 9,652,208**	
	Treatment							
	Catridge Filters			0.6	LS	$90,000	$ 52,000	Vendor quotes
	WBA Resin Vessels and Regeneration Equipment			0.6	LS	$6,791,700	$ 3,862,000	Vendor quotes
	Decarbonator			0.6	LS	$337,500	$ 192,000	Vendor quotes
	Chemical Dosing							
	Carbon Dioxide Feed System			2	LS	$308,050	$ 616,100	
	Carbon Dioxide Feed Water Pump			4	EA	$9,709	$ 38,836	
	Additional Pumping Requirements							
	Process Pumps	40	hp	3	EA	$33,000	$ 3,960,000	1 duty, 1 standy by at each site
	Bypass Water Pumps	25	hp	1	EA	$29,364	$ 734,096	1 duty, 1 standy by at each site
	Distribution Water Pumps	175	hp	3	EA	$65,725	$ 197,176	1 duty, 1 standy by at each site
13 - Special Construction							**$ -**	
15 - Mechanical							**$ 965,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$965,000	$ 965,000	10% of Division 11 Equipment
16 - Electrical							**$ 2,896,000**	
	Electrical Allowance	30%		1	LS	$2,896,000	$ 2,896,000	30% of Division 11 Equipment
17 - I&C							**$ 1,930,000**	
	I&C Allowance	20%		1	LS	$1,930,000	$ 1,930,000	20% of Division 11 Equipment

ANNUAL O&M COSTS			Quantity	Unit	Value	Cost	Notes
Consumables						**$ 1,127,000**	
	Catridge Filters		28,712	Elements/year	$23	$ 668,000	changed weekly
	Equipment Maintenance and Repair	2%	1	LS	$ 458,044	$ 459,000	2% of Equipment Cost
Power Costs						**$ 970,000**	
	Influent Feed Pumps		1,726,238	kW	$0.16	$ 280,000	
	Bypass Water Pumps		224,493	kW	$0.16	$ 36,000	
	Water Storage Tank Pump		740,109	kW	$0.16	$ 120,000	
	Distribution Water Pumps		3,213,319	kW	$0.16	$ 522,000	
	Decarbonator Blower		76,850	kW	$0.16	$ 12,000	
Chemical Costs						**$ 1,063,000**	
	Carbon Dioxide		5,441	per MG treated	$195.43	$ 1,063,000	
Labor						**$ 158,000**	
	Full Time Equivalents		2	person(s)			
	Total Annual Hours per Year		4,160	Labor Hours			
	Average Labor Rate	$	38	$/hour		$ 158,000	
					TOTAL ANNUAL O&M COSTS	$ 3,318,000	

NON-ANNUAL O&M COSTS	Reoccurance	Quantity	Unit	Value	Cost	Notes
Consumables	**Interval (yrs)**					
Replacement Resin	1.8	5,951	cubic feet	$524	$ 3,116,000	
Resin Disposal	1.8	119	Tons	$140	$ 17,000	
Pump Replacement	10	100%	Pump Cost	$128,089	$ 128,089	
Decarbonator Media	20	4,518	CF	$45	$ 203,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- SBA Treatment (Liquid Haul Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 3,089,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 339,000	
4 - Masonry			$ -	
5 - Metals			$ 76,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 11,939,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 4,233,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 1,194,000	
16 - Electrical			$ 2,388,000	
17 - Instrumentation and Control			$ 2,388,000	
		Raw Construction Subtotal	$ 28,146,000	
	25%	Construction Contingency	$ 7,037,000	
		Construction Cost Subtotal	**$ 35,183,000**	
	9%	Tax on Materials	$ 1,584,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 5,278,000	
		Estimated Total Construction Cost	**$ 42,045,000**	
	15%	Owner's Reserve for Change Orders	$ 6,307,000	
	10%	Environmental Documents and Permitting	$ 4,205,000	
	15%	Engineering Services (Design)	$ 6,307,000	
	13%	Construction Management	$ 5,466,000	
	12%	Engineering Services During Construction	$ 5,046,000	
		Estimated Total Capital Cost	**$ 69,376,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 3,089,000**	
	Mobilization	10%		1	LS	$3,088,645	$ 3,089,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 339,000**	
	Treatment Equipment							
	Slab for Catridge Filters			29	CY	$291	$ 8,000	
	Slab for Resin Vessels and Regeneration Equipment			190	CY	$291	$ 55,000	
	Chemical Storage Area							
	Wall			35	CY	$393	$ 14,000	
	Other Areas							
	Slab for Transformer			37	CY	$291	$ 11,000	
	Slab for Switchgear			19	CY	$291	$ 6,000	
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	
	Slab for Influent Water Pumps			47	CY	$291	$ 14,000	
	Slab for Bypass Water Pumps			26	CY	$291	$ 8,000	
	Slab for Product Water Transfer Pumps			47	CY	$291	$ 14,000	
	Slab for Effluent Water Tank			672	CY	$291	$ 196,000	
	Slab for Effluent Water Pump Station			15	CY	$291	$ 4,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 76,000**	
	Chain Link Fence around perimeter			1,461	LF	$52	$ 76,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 11,938,451**	
	Treatment							
	Cartridge Filters			2	EA	$90,000	$ 180,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			1	LS	$7,150,000	$ 7,150,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pumps	65	hp	3	EA	$39,060	$ 117,181	2 duty, 1 standy by
	Water Storage Pump	40	hp	2	EA	$33,000	$ 66,000	1 duty, 1 standy by
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	1 duty, 1 standy by
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	2 duty, 1 standy by
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431	ft	$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204	ft	$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194	ft	$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559	ft	$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580	ft	$601	$ 348,696	
	Distribution & Collection Piping							
	Distribution Lateral Connection	30	inch	1,000	ft	$752	$ 751,500	
	Sewer Lateral Piping	8	inch	100	ft	$200	$ 20,040	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 4,233,000**	
	Process Building							
	Process Building (Est. 240' x 140'; incl. equip. storage, elec. room, and staff facilities)			15,400	SF	$300	$ 4,620,000	
	Chemical Storage (105' x 40')			4,032	SF	$300	$ 1,210,000	
	Tanks							
	Distribution Water Tank with Storage for Nitrate Dilut	5,700,000	gallons	1	EA	$3,650,000.00	$3,650,000.00	Prestressed Concrete Tank
	Bulk Regen Salt Storage	70,500	gallons	2	EA	$2.24	$ 316,000	Steel Tank with Epoxy Coating
	Regeneration Brine Pit	50,000	gallons	1	EA	$2.22	$ 111,000	Steel Tank
	Influent Water Tank	70,000	gallons	1	EA	$2.22	$ 156,000	Steel Tank
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 1,194,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,194,000	$ 1,194,000	10% of Division 11 Equipment
16 - Electrical							**$ 2,388,000**	
	Electrical Allowance	20%		1	LS	$2,388,000	$ 2,388,000	20% of Division 11 Equipment
17 - I&C							**$ 2,388,000**	
	I&C Allowance	20%		1	LS	$2,388,000	$ 2,388,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit		Value	Cost	Notes
Consumables						**$ 665,000**	
Catridge Filters		18,304	Elements/year		$23	$ 426,000	changed weekly
Equipment Maintenance and Repair	2%	1	LS	$	238,769	$ 239,000	2% of Equipment Cost
Power Costs						**$ 562,000**	
Influent Feed Pumps		786,156	kW		$0.16	$ 128,000	
Bypass Water Pumps		143,116	kW		$0.16	$ 23,000	
Regeneration Pumps		4,357	kW		$0.16	$ 1,000	
Water Storage Tank Pump		471,824	kW		$0.16	$ 77,000	
Distribution Water Pumps		2,048,511	kW		$0.16	$ 333,000	
Chemical Costs						**$ 1,530,000**	
Brine Regenerant Solution		17,000	ton		$90.00	$ 1,530,000	
		653.85					
Disposal Costs						**$ 6,957,000**	
Regeneration Brine Disposal Fee		32,736,296	gallons		$0.05	$ 1,637,000	
Regeneration Brine Hauling Fee		32,736,296	gallons		$0.16	$ 5,320,000	
Labor						**$ 236,000**	
	Full Time Equivalents	3	person(s)				
	Total Annual Hours per Year	6,240	Labor Hours				
	Average Labor Rate	$ 38	$/hour			$ 236,000	
					TOTAL ANNUAL O&M COSTS	$ 9,950,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
Replacement Resin	7	2596	Cubic Feet	$203	$ 526,000	determine number of bed volumes
Resin Disposal Cost as Solid Waste	7	52	Tons	$43	$ 2,000	
Pump Replacement	10	100%	Pump Cost	$457,265	$ 457,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- SBA Treatment Expansion (Liquid Haul Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 556,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 3,598,000	
13 - Special Construction			$ 158,000	
15 - Mechanical			$ 360,000	
16 - Electrical			$ 720,000	
17 - Instrumentation and Control			$ 720,000	
		Raw Construction Subtotal	$ 6,112,000	
	25%	Construction Contingency	$ 1,528,000	
		Construction Cost Subtotal	**$ 7,640,000**	
	9%	Tax on Materials	$ 344,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 1,146,000	
		Estimated Total Construction Cost	**$ 9,130,000**	
	15%	Owner's Reserve for Change Orders	$ 1,370,000	
	10%	Environmental Documents and Permitting	$ 913,000	
	15%	Engineering Services (Design)	$ 1,370,000	
	13%	Construction Management	$ 1,187,000	
	12%	Engineering Services During Construction	$ 1,096,000	
		Estimated Total Capital Cost	**$ 15,066,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 556,000**	
	Mobilization	10%		1	LS	$555,572	$ 556,000	10% of Divisions 2-17
2 - Sitework							**$ -**	
3 - Concrete							**$ -**	
5 - Metals							**$ -**	
9 - Finishes							**$ -**	
11 - Equipment							**$ 3,597,720**	
	Treatment							
	Catridge Filters			0.6	LS	$90,000	$ 52,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			0.6	LS	$5,630,300	$ 3,202,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pumps	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Bypass Water Pumps	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	1 duty, 1 standy by at each site
13 - Special Construction							**$ 158,000**	
	Bulk Regen Salt Storage	70,500	gallons	1	EA	$2.24	$ 158,000	Steel Tank with Epoxy Coating
15 - Mechanical							**$ 360,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$360,000	$ 360,000	10% of Division 11 Equipment
16 - Electrical							**$ 720,000**	
	Electrical Allowance	20%		1	LS	$720,000	$ 720,000	20% of Division 11 Equipment
17 - I&C							**$ 720,000**	
	I&C Allowance	20%		1	LS	$720,000	$ 720,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 979,000**	
	Catridge Filters	28,712	Elements/year	$23	$ 668,000	changed weekly
	Equipment Maintenance and Repair 2%	1	LS	$ 310,954	$ 311,000	2% of Equipment Cost
Power Costs					**$ 804,000**	
	Influent Feed Pumps	1,037,894	kW	$0.16	$ 169,000	
	Bypass Water Pumps	210,173	kW	$0.16	$ 34,000	
	Regeneration Pumps	112,093	kW	$0.16	$ 18,000	
	Water Storage Tank Pump	373,642	kW	$0.16	$ 61,000	
	Distribution Water Pumps	3,213,319	kW	$0.16	$ 522,000	
Chemical Costs					**$ 2,400,000**	
	Brine Regenerant Solution	26,667	ton	$90.00	$ 2,400,000	
Disposal Costs					**$ 10,912,000**	
	Regeneration Brine Disposal Fee	51,350,550	gallons	$0.05	$ 2,568,000	
	Regeneration Brine Hauling Fee	51,350,550	gallons	$0.16	$ 8,344,000	
Labor					**$ 236,000**	
	Full Time Equivalents	3	person(s)			
	Total Annual Hours per Year	6,240	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 236,000	
				TOTAL ANNUAL O&M COSTS	$ 15,331,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
	Replacement Resin	7	4072	LS/Vessel	$203	$ 825,000	determine number of bed volumes
	Resin Disposal Cost as Solid Waste	7	81	Tons	$43	$ 3,000	
	Pump Replacement	10	100%	Pump Cost	$104,786	$ 105,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- Reverse Osmosis Treatment

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 4,630,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 169,000	
4 - Masonry			$ -	
5 - Metals			$ 85,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 19,591,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 2,074,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 1,959,000	
16 - Electrical			$ 3,918,000	
17 - Instrumentation and Control			$ 3,918,000	
		Raw Construction Subtotal	$ 38,844,000	
	25%	Construction Contingency	$ 9,711,000	
		Construction Cost Subtotal	**$ 48,555,000**	
	9%	Tax on Materials	$ 2,185,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 7,284,000	
		Estimated Total Construction Cost	**$ 58,024,000**	
	15%	Owner's Reserve for Change Orders	$ 8,704,000	
	10%	Environmental Documents and Permitting	$ 5,803,000	
	15%	Engineering Services (Design)	$ 8,704,000	
	13%	Construction Management	$ 7,544,000	
	12%	Engineering Services During Construction	$ 6,963,000	
		Estimated Total Capital Cost	**$ 95,742,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 4,630,000**	
	Mobilization	10%		1	LS	$4,629,625	$ 4,630,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 169,000**	
	Influent Pumping							
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	
	Slab for Influent Pump Station			15	CY	$291	$ 4,000	
	Slab for Bypass Pump Station			11	CY	$291	$ 3,000	
	Treatment Equipment							
	Slab for Interprocess Area			51	CY	$291	$ 15,000	
	Slab for Cartridge Filters			53	CY	$291	$ 15,000	
	Slab for RO Feed Pumps			26	CY	$291	$ 8,000	
	UF Reverse Filtration Pumps			7	CY	$291	$ 2,000	
	Slab for Lamella Clarifier			49	CY	$291	$ 14,000	
	Slab for Spent Backwash Water Storage			14	CY	$291	$ 4,000	
	Slab for Transfer Pumps			11	CY	$291	$ 3,000	
	Chemical Storage							
	Chemical Storage Containment Area							
	Walls			32	CY	$393	$ 13,000	
	Electrical							
	Slab for Electrical Switchgear			19	CY	$291	$ 6,000	
	Slab for Electrical Transformer			37	CY	$291	$ 11,000	
	Distribution Pumping							
	Slab for Effluent Water Pump Station			15	CY	$291	$ 4,000	
	Slab for Effluent Water Tank			200	CY	$291	$ 58,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 85,000**	
	Chain Link Fence around perimeter			1,635	LF	$52	$ 85,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 19,590,252**	
	Influent Pumping							
	Influent Automatic Strainers			5	EA	$16,000	$ 80,000	Estimated from installed cost of SVAWPC automatic strainers
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	2 duty, 1 standy by
	Filtration Treatment							
	Ultrafiltration Treatment			1	LS	$4,230,000	$ 4,230,000	Vendor quotes
	Lamella Clarifier			1	LS	$1,197,000	$ 1,197,000	Vendor quotes
	Inter-Process Tank			225,000	GAL	$2	$ 499,000	40' diameter; size based on SVAWPC
	Reverse Osmosis			1	LS	$3,975,000	$ 3,975,000	Vendor quotes; Package includes feed pumps, membrane system, CIP system
	Decarbonator			0	LS	$337,500	$ -	Vendor quotes
	Additional Pumping Requirements							
	RO Transfer Pumps	50	hp	3	EA	$35,424	$ 106,272	1 duty, 1 standy by
	Decarbonator Feed Pump	40	hp	0	EA	$33,000	$ -	1 duty, 1 standy by
	Water Storage Pump	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	1 duty, 1 standy by
	Waste Pumps	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431	ft	$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204	ft	$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194	ft	$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559	ft	$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580	ft	$601	$ 348,696	
	Distribution & Collection Piping							
	Waste Stream Pipe	21	inch	9,400	ft	$526	$ 4,944,870	
	Distribution Lateral Connection	30	inch	1,000	ft	$752	$ 751,500	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 2,074,000**	
	Process Building							
	Process Building (Est. 240' x 140'; incl. equip. storage, elec. room, and staff facilities)			33,600	SF	$300	$ 10,080,000	
	Chemical Storage (105' x 40')			4,200	SF	$300	$ 1,260,000	
	CIP (Est. 45' x 55')			2475	SF	$300	$ 743,000	
	Tanks							
	Sodium Bisulfite Tank	6,500	gallons	0	EA	$10,124	$ -	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sodium Hydroxide Tank	15,500	gallons	1	EA	$37,187	$ 38,000	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sulfuric Acid Tank	6,500	gallons	0	EA	$10,124		Vendor Quote from Harrington Plastics Catalog (18th edition)
	Antiscalant Tank	2,000	gallons	1	EA	$2,589	$ 3,000	
	Distribution Water Tank	809,000	gallons	1	EA	$1	$ 1,092,000	
	Influent Water Tank	70,000	gallons	1	EA	$2	$ 156,000	
	Lamella Clarifier Equalization Storage	500,000	gallons	1	EA	$2	$ 785,000	
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 1,959,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,959,000	$ 1,959,000	10% of Division 11 Equipment
16 - Electrical							**$ 3,918,000**	
	Electrical Allowance	20%		1	LS	$3,918,000	$ 3,918,000	20% of Division 11 Equipment
17 - I&C							**$ 3,918,000**	
	I&C Allowance	20%		1	LS	$3,918,000	$ 3,918,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 605,000**	
Catridge Filters		9152	Elements/year	23.26	$ 213,000	2 week interval change out
Equipment Maintenance and Repair	2%	1	LS	$ 391,805	$ 392,000	2% of Equipment Cost
Power Costs					**$ 1,617,718**	
Influent Pumps/MF feed		285,839	kW	$0.16	$ 46,000	
Bypass Water Pumps		143,116	kW	$0.16	$ 23,000	
MF CIP		72,131	kW	$0.16	$ 12,000	
MF Air Scour		1,176,293	kW	$0.16	$ 191,000	
RO Pumps		5,339,632	kW	$0.16	$ 867,000	
RO interstage pump		133,987	kW	$0.16	$ 22,000	
RO CIP pumps		66,010	kW	$0.16	$ 10,718	
RO transfer Pump		133,987	kW	$0.16	$ 22,000	
Decarbonator Feed Pump	471,824		kW	$0.16	$ -	
Water Storage Tank Pump		471,824	kW	$0.16	$ 77,000	
Decarbonator Blower	48,992		kW	$0.16	$ -	
Chemical Metering Pumps		84,886	kW	$0.16	$ 14,000	
Distribution Water Pump		2,048,511	kW	$0.16	$ 333,000	
Chemical Costs					**$ 885,000**	
Sodium Bisulfite			gal	$1.32	$ -	Engineer's estimate
Citric Acid		5,492	gal	$6.04	$ 33,000	Vendor estimate
Sodium Hydroxide		186,000	gal	$2.50	$ 465,000	Engineer's estimate
Sulfuric Acid			gal	$1.00	$ -	Engineer's estimate
Antiscalant		23,000	gal	$16.82	$ 387,000	Vendor estimate
Labor					**$ 236,000**	
	Full Time Equivalents	3	person(s)			See Sunnyvale TM for discussion of FTEs.
	Total Annual Hours per Year	6,240	Labor Hours			
	Average Labor Rate	$ 38	$/hour		$ 236,000	
				TOTAL ANNUAL O&M COSTS	$ 3,343,718	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
UF Membranes	3	450	Membranes	$1,850	$ 833,000	
RO Membrances	5	1512	Membranes	$650	$ 983,000	
Pump Replacement	10	100%	Pump Cost	$229,513	$ 229,513	
Decarbonator Media	20	2880	CF	$45		

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- Reverse Osmosis Treatment Expansion

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 843,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 5,620,000	
13 - Special Construction			$ -	
15 - Mechanical			$ 562,000	
16 - Electrical			$ 1,124,000	
17 - Instrumentation and Control			$ 1,124,000	
		Raw Construction Subtotal	$ 9,273,000	
25%		Construction Contingency	$ 2,319,000	
		Construction Cost Subtotal	**$ 11,592,000**	
9%		Tax on Materials	$ 522,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15%		General Contractor Overhead and Profit	$ 1,739,000	
		Estimated Total Construction Cost	**$ 13,853,000**	
15%		Owner's Reserve for Change Orders	$ 2,078,000	
10%		Environmental Documents and Permitting	$ 1,386,000	
15%		Engineering Services (Design)	$ 2,078,000	
13%		Construction Management	$ 1,801,000	
12%		Engineering Services During Construction	$ 1,663,000	
		Estimated Total Capital Cost	**$ 22,859,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 843,000**	
	Mobilization	10%		1	LS	$842,931	$ 843,000	10% of Divisions 2-17
11 - Equipment							**$ 5,619,306**	
	Influent Pumping							
	Influent Automatic Strainers			3	EA	$16,000	$ 48,000	Estimated from installed cost of SVAWPC automatic strainers
	Bypass Water Pumps	25	hp	1	EA	$29,364	$ 734,096	1 duty, 1 standy by at each site
	Filtration Treatment							
	Ultrafiltration Treatment			0.6	LS	$4,230,000	$ 2,406,000	Vendor quotes
	Reverse Osmosis			0.6	LS	$3,975,000	$ 2,261,000	Vendor quotes; Package includes feed pumps, membrane system, CIP system
	Inter-Process Pump	25	hp	1	LS	$29,364	$ 30,000	
	Additional Pumping Requirements							
	RO Transfer Pumps	50	hp	1	EA	$35,424	$ 35,424	
	Water Storage Pump	40	hp	1	EA	$33,000	$ 33,000	
	Distribution Water Pumps	200	hp	1	EA	$71,786	$ 71,786	
13 - Special Construction							**$ -**	
15 - Mechanical							**$ 562,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$562,000	$ 562,000	10% of Division 11 Equipment
16 - Electrical							**$ 1,124,000**	
	Electrical Allowance	20%		1	LS	$1,124,000	$ 1,124,000	20% of Division 11 Equipment
17 - I&C							**$ 1,124,000**	
	I&C Allowance	20%		1	LS	$1,124,000	$ 1,124,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 672,000**	
	Catridge Filters	7,178	Elements/year	23.26	$ 167,000	2 week interval change out
	Equipment Maintenance and Repair 2%	1	LS	$ 504,386	$ 505,000	2% of Equipment Cost
Power Costs					**$ 2,536,000**	
	Influent Pumps/MF feed	448,370	kW	$0.16	$ 73,000	
	Bypass Water Pumps	224,493	kW	$0.16	$ 36,000	
	MF CIP	113,146	kW	$0.16	$ 18,000	
	MF Air Scour	1,845,147	kW	$0.16	$ 300,000	
	RO Pumps	8,375,811	kW	$0.16	$ 1,360,000	
	RO interstage pump	210,173	kW	$0.16	$ 34,000	
	RO CIP pumps	103,543	kW	$0.16	$ 17,000	
	RO transfer Pump	210,173	kW	$0.16	$ 34,000	
	Water Storage Tank Pump	740,109	kW	$0.16	$ 120,000	
	Chemical Metering Pumps	133,153	kW	$0.16	$ 22,000	
	Distribution Water Pump	3,213,319	kW	$0.16	$ 522,000	
Chemical Costs					**$ 1,388,000**	
	Sodium Bisulfite	-	gal	$1.32	$ -	Engineer's estimate
	Citric Acid	8,615	gal	$6.04	$ 52,000	Vendor estimate
	Sodium Hydroxide	291,762	gal	$2.50	$ 729,000	Engineer's estimate
	RO Antiscalant	36,078	gal	$16.82	$ 607,000	Vendor estimate
Labor					**$ 236,000**	
	Full Time Equivalents	3	person(s)			See Sunnyvale TM for discussion of FTEs.
	Total Annual Hours per Year	6,240	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 236,000	
				TOTAL ANNUAL O&M COSTS	$ 4,832,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
UF Membranes	3	706	Membranes	$1,850	$ 1,306,000	
RO Membrances	5	2372	Membranes	$650	$ 1,542,000	
Pump Replacement	10	100%	Pump Cost	$231,937	$ 232,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- RCF Treatment (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By: SSH
Check Date: 12/16/2016

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division	Subtotal	Notes
1 - General Requirements	$ 526,000	
2 - Sitework	$ 250,000	
3 - Concrete	$ 22,000	
4 - Masonry	$ -	
5 - Metals	$ 20,000	
6 - Wood and Plastic	$ -	
7 - Moisture and Thermal Protection	$ -	
8 - Doors and Windows	$ -	
9 - Finishes	$ -	
10 - Specialties	$ -	
11 - Equipment	$ 3,172,000	
12 - Furnishings	$ -	
13 - Special Construction	$ 210,000	
14 - Conveying Systems	$ -	
15 - Mechanical	$ 317,000	
16 - Electrical	$ 634,000	
17 - Instrumentation and Control	$ 634,000	
Raw Construction Subtotal	$ 5,785,000	
25% Construction Contingency	$ 1,447,000	
Construction Cost Subtotal	**$ 7,232,000**	
9% Tax on Materials	$ 326,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15% General Contractor Overhead and Profit	$ 1,085,000	
Estimated Total Construction Cost	**$ 8,643,000**	
15% Owner's Reserve for Change Orders	$ 1,297,000	
10% Environmental Documents and Permitting	$ 865,000	
15% Engineering Services (Design)	$ 1,297,000	
13% Construction Management	$ 1,124,000	
12% Engineering Services During Construction	$ 1,038,000	
Estimated Total Capital Cost	**$ 14,264,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 526,000**	
	Mobilization	10%		1	LS	$525,800	$ 526,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 22,000**	
	Treatment Equipment							
	Slab for Reduction Tank			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Aeration Chamber			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Backwash Water Storage			6	CY	$291	$ 2,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Lamella Clarifier			2	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Screw Press				CY	$291	$ -	2016 Means HCCD 03 30 53.40 3590
	Solids Storage				CY	$291	$ -	2016 Means HCCD 03 30 53.40 3590
	Chemical Storage and CIP							
	Chemical Storage Containment Area							
	Secondary Containment Walls			6	CY	$393	$ 2,000	2016 Means HCCD 03 30 53.40 4200
	CIP Area							
	Secondary Containment Walls			16	CY	$393	$ 6,000	2016 Means HCCD 03 30 53.40 4200
	Distribution Pumping							
	Product Water Tank			5	CY	$291	$ 1,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Pump Station			7	CY	$291	$ 2,000	2016 Means HCCD 03 30 53.40 3590
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 20,000**	
	Chain Link Fence around perimeter			384	LF	$52	$ 20,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 3,171,243**	
	Treatment							
	Reduction, Aeration, Filtration			1	LS	$2,811,000	$ 2,811,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			1	LS	$228,000	$ 228,000	Vendor quotes
	Screw Press				LS	$217,500	$ -	Vendor quotes
	Additional Pumping Requirements							
	Storage Tank Pump	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by at each site
	Distribution Water Pumps	50	hp	2	EA	$35,424	$ 70,848	1 duty, 1 standy by at each site
	Waste Collection Piping							
	Lateral Connection to Sewer	6	inch	50	ft	$150	$ 7,515	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 209,757**	
	Tanks							
	Ferrous Sulfate	1,000	gallons	1	EA	$1,802	$1,802	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Sodium Hypochlorite	500	gallons	1	EA	$969	$969	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Lamella Clarifier Equalization Storage	6,000	gallons	1	EA	$9,410	$9,410	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Solids Storage Tank	3,000	gallons		EA	$6,368	$0	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Treated Water Tank	5,000	gallons	1	EA	$10,077	$10,077	Vendor Quote from Harrington Plastics Catalog (18th edition)
	Building (CMU Construction)							
	Process and Electrical (assume 15' x 25')	1	EA	375	SF	$300	$112,500	Engineer's Estimate
	Chemical Storage and CIP (assume 10' x 25')	1	EA	250	SF	$300	$75,000	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 317,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$317,000	$ 317,000	10% of Division 11 Equipment
16 - Electrical							**$ 634,000**	
	Electrical Allowance	20%		1	LS	$634,000	$ 634,000	20% of Division 11 Equipment
17 - I&C							**$ 634,000**	
	I&C Allowance	20%		1	LS	$634,000	$ 634,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 64,000**	
Equipment Maintenance and Repair	2%	1	LS	$ 63,425	$ 64,000	2% of Equipment Cost
Power Costs					**$ 109,000**	
UF		41,161	kW	$0.16	$ 7,000	
UF CIP		72,131	kW	$0.16	$ 12,000	
UF Air Scour		169,386	kW	$0.16	$ 28,000	
Chemical Metering Pumps		45,708	kW	$0.16	$ 7,000	Assumed 7 chemical metering pumps
Water Storage Tank Pump		98,024	kW	$0.16	$ 16,000	
Distribution Water Pumps		238,199	kW	$0.16	$ 39,000	
Screw Press			kW	$0.16	$ -	
Chemical Costs					**$ 19,400**	
Ferrous Sulfate		8,952	gal	$1.25	$ 11,000	
Sodium Hypochlorite		6,056	gal	$0.40	$ 2,400	CIP and Ferrous Sulfate Reduction
Citric Acid		791	gal	$6.04	$ 5,000	CIP
Polymer		266	lbs	$4.00	$ 1,000	
Disposal Costs					**$ -**	
Dewatered Waste Disposal at 20% Solids (includes transportation)		0	Tons	$140	$ -	

Labor COSTS		Quantity	Unit	Cost	Notes
				$ 315,000	
Initial 7 wells:	Full Time Equivalents	4	person(s)		
	Total Annual Hours per Year	8,320	Labor Hours		
	Average Labor Rate $	38	$/hour	$ 315,000	
Every Well Install After first 7 wells:	Full Time Equivalents	0.5	person(s)		
	Total Annual Hours per Year	1,040	Labor Hours		
	Average Labor Rate $	38	$/hour	$ 39,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
UF Membranes		5	76	Membranes	$1,850	$ 141,000	
Pump Replacement		10	100%	Pump Cost	$124,728	$ 125,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Individual Wellhead- SBA Treatment (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division		Subtotal	Notes
1 - General Requirements		$ 343,000	
2 - Sitework		$ 250,000	
3 - Concrete		$ 11,000	
4 - Masonry		$ -	
5 - Metals		$ 33,000	
6 - Wood and Plastic		$ -	
7 - Moisture and Thermal Protection		$ -	
8 - Doors and Windows		$ -	
9 - Finishes		$ -	
10 - Specialties		$ -	
11 - Equipment		$ 1,311,000	
12 - Furnishings		$ -	
13 - Special Construction		$ 1,173,000	
14 - Conveying Systems		$ -	
15 - Mechanical		$ 131,000	
16 - Electrical		$ 262,000	
17 - Instrumentation and Control		$ 262,000	
	Raw Construction Subtotal	$ 3,776,000	
25%	Construction Contingency	$ 944,000	
	Construction Cost Subtotal	**$ 4,720,000**	
9%	Tax on Materials	$ 213,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
15%	General Contractor Overhead and Profit	$ 708,000	
	Estimated Total Construction Cost	**$ 5,641,000**	
15%	Owner's Reserve for Change Orders	$ 847,000	
10%	Environmental Documents and Permitting	$ 565,000	
15%	Engineering Services (Design)	$ 847,000	
13%	Construction Management	$ 734,000	
12%	Engineering Services During Construction	$ 677,000	
	Estimated Total Capital Cost	**$ 9,311,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 343,000**	
	Mobilization	10%		1	LS	$343,224	$ 343,000	10% of Divisions 2-17
2 - Sitework							**$ 250,000**	
	Allowance for Site Work			1	LS	$150,000	$ 150,000	
	Yard Piping Allowance			1	LS	$100,000	$ 100,000	
3 - Concrete							**$ 11,000**	
	Treatment Equipment							
	Slab for Catridge Filters			1	CY	$291	$ -	
	Slab for Resin Vessels and Regeneration Equipment			28	CY	$291	$ 8,000	
	Distribution Pumping							
	Product Water Tank			5	CY	$291	$ 1,000	
	Slab for Pump Station			7	CY	$291	$ 2,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 33,000**	
	Chain Link Fence around perimeter			643	LF	$52	$ 33,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 1,310,243**	
	Treatment							
	Catridge Filters			1	LS	$39,000	$ 39,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			1	LS	$1,138,650	$ 1,139,000	Vendor quotes
	Additional Pumping Requirements							
	Storage Tank Pump	15	hp	2	EA	$26,940	$ 53,880	1 duty, 1 standy by at each site
	Distribution Water Pumps	50	hp	2	EA	$35,424	$ 70,848	1 duty, 1 standy by at each site
	Waste Collection Piping							
	Lateral Connection to Sewer	6	inch	50	ft	$150	$ 7,515	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 1,173,000**	
	Tanks							
	Distribution Water Tank with Storage for Nitrate Dilution	858,000	gallons	1	EA	$1	$ 1,158,000	Steel Tank
	Building (CMU Construction)							
	Electrical (assume 5' x 10')	1	EA	50	SF	$300	$15,000	Engineer's Estimate
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 131,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$131,000	$ 131,000	10% of Division 11 Equipment
16 - Electrical							**$ 262,000**	
	Electrical Allowance	20%		1	LS	$262,000	$ 262,000	20% of Division 11 Equipment
17 - I&C							**$ 262,000**	
	I&C Allowance	20%		1	LS	$262,000	$ 262,000	20% of Division 11 Equipment

ANNUAL O&M COSTS			Quantity	Unit		Value	Cost	Notes
Consumables							**$ 90,000**	
	Catridge Filters		2,704	Elements/year		$23	$ 63,000	changed weekly
	Equipment Maintenance and Repair	2%	1	LS	$	26,205	$ 27,000	2% of Equipment Cost 20% of Division 11 Equipment
Power Costs							**$ 56,000**	
	Water Storage Tank Pump		98,024	kW		$0.16	$ 16,000	
	Regeneration Pumps		4,357	kW		$0.16	$ 1,000	
	Distribution Water Pumps		238,199	kW		$0.16	$ 39,000	
Chemical Costs							**$ 212,000**	
	Regenerant Salt		2,357	ton		$90.00	$ 212,000	regeneration estimated at every 10.5 hours of operation
Disposal Costs							**$ -**	
	Regeneration Brine Disposal Fee			gallons		$0.05	$ -	
	Regeneration Brine Hauling Fee			gallons		$0.16	$ -	
Labor							**$ 236,000**	
		Full Time Equivalents	3	person(s)				
		Total Annual Hours per Year	6,240	Labor Hours				
		Average Labor Rate	$ 38	$/hour			$ 236,000	
	Every Well Install After first 7 wells:	Full Time Equivalents	0.5	person(s)				
		Total Annual Hours per Year	1,040	Labor Hours				
		Average Labor Rate	$ 38	$/hour			$ 39,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
	Resin Replacement	7	424	CF	$203	$ 85,860	
	Resin Disposal Cost as Solid Waste	7	8	Tons	$43	$ 360	
	Pump Replacement	10	100%	Pump Cost	$124,728	$ 124,728	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- RCF Treatment (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 4,704,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 214,000	
4 - Masonry			$ -	
5 - Metals			$ 78,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 22,682,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 10,225,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 2,268,000	
16 - Electrical			$ 4,536,000	
17 - Instrumentation and Control			$ 4,536,000	
		Raw Construction Subtotal	$ 51,743,000	
	25%	Construction Contingency	$ 12,936,000	
		Construction Cost Subtotal	**$ 64,679,000**	
	9%	Tax on Materials	$ 2,911,000	Percentage of materials costs (materials cost estimate as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 9,702,000	
		Estimated Total Construction Cost	**$ 77,292,000**	
	15%	Owner's Reserve for Change Orders	$ 11,594,000	
	10%	Environmental Documents and Permitting	$ 7,730,000	
	15%	Engineering Services (Design)	$ 11,594,000	
	13%	Construction Management	$ 10,048,000	
	12%	Engineering Services During Construction	$ 9,276,000	
		Estimated Total Capital Cost	**$ 127,534,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 4,704,000**	
	Mobilization	10%		1	LS	$4,703,826	$ 4,704,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 214,000**	
	Treatment Equipment							
	Slab for Reduction and Oxidation/Coagulation Tanks			249	CY	$291	$ 72,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Backwash Water Storage			51	CY	$291	$ 15,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Spent Backwash Water Storage			14	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Lamella Clarifier			60	CY	$291	$ 17,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Screw Press				CY	$291	$ -	2016 Means HCCD 03 30 53.40 3590
	Chemical Storage							
	Secondary Containment Walls			17	CY	$393	$ 7,000	2016 Means HCCD 03 30 53.40 4200
	CIP Area							
	Secondary Containment Walls			10	CY	$393	$ 4,000	2016 Means HCCD 03 30 53.40 4200
	Other Areas							
	Slab for Bypass Pump Station			11	CY	$291	$ 3,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Solids Storage				CY	$291	$ -	2016 Means HCCD 03 30 53.40 3590
	Slab for Transformer			37	CY	$291	$ 11,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Switchgear			19	CY	$291	$ 6,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Influent Water Pump Station Slab			15	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Effluent Water Tank			200	CY	$291	$ 58,000	2016 Means HCCD 03 30 53.40 3590
	Slab for Effluent Water Pump Station Slab			15	CY	$291	$ 4,000	2016 Means HCCD 03 30 53.40 3590
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 78,000**	
	Chain Link Fence around perimeter			1,508	LF	$52	$ 78,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 22,681,260**	
	Treatment							
	Reduction, Aeration, Filtration			1	LS	$16,866,000	$ 16,866,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			1	LS	$1,197,000	$ 1,197,000	Vendor quotes
	Screw Press				LS	$217,500	$ -	Vendor quotes
	Additional Pumping Requirements							
	Influent Process Pumps	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	1 duty, 1 standy by at each site
	Water Storage Tank Pump	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	1 duty, 1 standy by at each site
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431 ft		$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204 ft		$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194 ft		$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559 ft		$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580 ft		$601	$ 348,696	
	Distribution & Collection Piping							
	Sewer Lateral Connection	6	inch	100 ft		$150	$ 15,030	
	Distribution Lateral Connection	30	inch	1,000 ft		$752	$ 751,500	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 10,225,000**	
	Buildings (CMU Construction)							
	Process Building (Est. 140' x 180'; incl. equip. storage, elec. room, and staff facilities)			25,200	SF	$300	$ 7,560,000	
	Chemical Storage (15' x 30')			450	SF	$300	$ 135,000	
	CIP (Est. 45' x 35')			1575	SF	$300	$ 473,000	
	Tanks							
	Ferrous Sulfate	10,500	gallons	1	EA	$16,017	$ 17,000	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Sodium Hypochlorite	3,500	gallons	1	EA	$6,368	$ 7,000	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Lamella Clarifier Equalization Storage	500,000	gallons	1	EA	$2	$ 785,000	
	Sludge Storage Tank	6,500	gallons		EA	$10,124	$ -	Vendor Quote from Harrington Plastics Catalog (18tl edition)
	Distribution Water Tank	809,000	gallons	1	EA	$1	$ 1,092,000	
	Influent Water Tank	70,000	gallons	1	EA	$2	$ 156,000	
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 2,268,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$2,268,000	$ 2,268,000	10% of Division 11 Equipment
16 - Electrical							**$ 4,536,000**	
	Electrical Allowance	20%		1	LS	$4,536,000	$ 4,536,000	20% of Division 11 Equipment
17 - I&C							**$ 4,536,000**	
	I&C Allowance	20%		1	LS	$4,536,000	$ 4,536,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 454,000**	
	Equipment Maintenance and Repair 2%	1	LS	$ 453,625	$ 454,000	2% of Equipment Cost
Power Costs					**$ 1,048,000**	
	Process Pumps	471,824	kW	$0.16	$ 77,000	
	Bypass Water Pumps	143,116	kW	$0.16	$ 23,000	
	UF Feed Pumps	2,050,582	kW	$0.16	$ 333,000	
	UF CIP	72,131	kW	$0.16	$ 12,000	
	UF Air Scour	1,176,293	kW	$0.16	$ 191,000	
	Screw Press		kW	$0.16	$ -	
	Water Storage Tank Pump	471,824	kW	$0.16	$ 77,000	
	Chemical Metering Pumps	13,059	kW	$0.16	$ 2,000	Assumed 2 chemical metering pumps
	Distribution Water Pumps	2,048,511	kW	$0.16	$ 333,000	
Chemical Costs					**$ 155,000**	
	Ferrous Sulfate	78,000	gal	$1.25	$ 98,000	
	CIP Caustic (Sodium Hypochlorite)	42,053	gal	$0.40	$ 17,000	
	CIP Acid (Citric Acid)	5,492	gal	$6.04	$ 33,000	
	Polymer	1,683	lbs	$4.00	$ 7,000	
Disposal Costs					**$ -**	
	Dewatered Waste Disposal at 20% Solids (includes transportation)		Tons	$140	$ -	
Labor					**$ 315,000**	
	Full Time Equivalents	4	person(s)			
	Total Annual Hours per Year	8,320	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 315,000	
				TOTAL ANNUAL O&M COSTS	$ 1,972,000	

NON-ANNUAL O&M COSTS		Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables							
	MF Membranes	3	450	Membranes	$1,850	$ 833,000	
	Pump Replacement	10	100%	Pump Cost	$472,084	$ 472,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- RCF Treatment Expansion (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 1,565,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 10,436,000	
13 - Special Construction			$ -	
15 - Mechanical			$ 1,044,000	
16 - Electrical			$ 2,087,000	
17 - Instrumentation and Control			$ 2,087,000	
		Raw Construction Subtotal	$ 17,219,000	
	25%	Construction Contingency	$ 4,305,000	
		Construction Cost Subtotal	**$ 21,524,000**	
	9%	Tax on Materials	$ 969,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 3,229,000	
		Estimated Total Construction Cost	**$ 25,722,000**	
	15%	Owner's Reserve for Change Orders	$ 3,859,000	
	10%	Environmental Documents and Permitting	$ 2,573,000	
	15%	Engineering Services (Design)	$ 3,859,000	
	13%	Construction Management	$ 3,344,000	
	12%	Engineering Services During Construction	$ 3,087,000	
		Estimated Total Capital Cost	**$ 42,444,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 1,565,000**	
	Mobilization	10%		1	LS	$1,565,351	$ 1,565,000	10% of Divisions 2-17
2 - Sitework							**$ -**	
3 - Concrete							**$ -**	
5 - Metals							**$ -**	
9 - Finishes							**$ -**	
11 - Equipment							**$ 10,435,513**	
	Treatment							
	Reduction, Coagulation, Filtration			0.6	LS	$16,866,000	$ 9,591,000	Vendor quotes
	Backwash Handling							
	Lamella Clarifier			0.6	LS	$1,197,000	$ 681,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pump	40	hp	1	EA	$33,000	$ 33,000	1 duty, 1 standy by at each site
	Bypass Water Pump	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Water Storage Tank Pump	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Distribution Water Pump	200	hp	1	EA	$71,786	$ 71,786	1 duty, 1 standy by at each site
13 - Special Construction							**$ -**	
15 - Mechanical							**$ 1,044,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,044,000	$ 1,044,000	10% of Division 11 Equipment
16 - Electrical							**$ 2,087,000**	
	Electrical Allowance	20%		1	LS	$2,087,000	$ 2,087,000	20% of Division 11 Equipment
17 - I&C							**$ 2,087,000**	
	I&C Allowance	20%		1	LS	$2,087,000	$ 2,087,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 663,000**	
	Equipment Maintenance and Repair 2%	1	LS	$ 662,710	$ 663,000	2% of Equipment Cost
Power Costs					**$ 1,641,000**	
	Process Pumps	740,109	kW	$0.16	$ 120,000	
	Bypass Water Pumps	224,493	kW	$0.16	$ 36,000	
	UF Feed Pumps	3,216,568	kW	$0.16	$ 522,000	
	UF CIP	113,146	kW	$0.16	$ 18,000	
	UF Air Scour	1,845,147	kW	$0.16	$ 300,000	
	Screw Press	0	kW	$0.16	$ -	
	Water Storage Tank Pump	740,109	kW	$0.16	$ 120,000	
	Chemical Metering Pumps	20,485	kW	$0.16	$ 3,000	
	Distribution Water Pumps	3,213,319	kW	$0.16	$ 522,000	
Chemical Costs					**$ 242,000**	
	Ferrous Sulfate	122,352	gal	$1.25	$ 153,000	
	CIP Caustic (Sodium Hypochlorite)	65,964	gal	$0.40	$ 26,000	
	CIP Acid (Citric Acid)	8,615	gal	$6.04	$ 52,000	
	Polymer	2,639	lbs	$4.00	$ 11,000	
Disposal Costs					**$ -**	
	Dewatered Waste Disposal at 20% Solids	-	CY	$140	$ -	
Labor					**$ 315,000**	
	Full Time Equivalents	4	person(s)			
	Total Annual Hours per Year	8,320	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 315,000	
				TOTAL ANNUAL O&M COSTS	$ 2,861,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables					**$ 1,411,000**	
MF Membranes	3	706	Membranes	$1,850	$ 1,306,000	
Pump Replacement	10	100%	Pump Cost	$104,786	$ 105,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- SBA Treatment (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 3,089,000	
2 - Sitework			$ 2,500,000	
3 - Concrete			$ 339,000	
4 - Masonry			$ -	
5 - Metals			$ 76,000	
6 - Wood and Plastic			$ -	
7 - Moisture and Thermal Protection			$ -	
8 - Doors and Windows			$ -	
9 - Finishes			$ -	
10 - Specialties			$ -	
11 - Equipment			$ 11,939,000	
12 - Furnishings			$ -	
13 - Special Construction			$ 4,233,000	
14 - Conveying Systems			$ -	
15 - Mechanical			$ 1,194,000	
16 - Electrical			$ 2,388,000	
17 - Instrumentation and Control			$ 2,388,000	
		Raw Construction Subtotal	$ 28,146,000	
	25%	Construction Contingency	$ 7,037,000	
		Construction Cost Subtotal	**$ 35,183,000**	
	9%	Tax on Materials	$ 1,584,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 5,278,000	
		Estimated Total Construction Cost	**$ 42,045,000**	
	15%	Owner's Reserve for Change Orders	$ 6,307,000	
	10%	Environmental Documents and Permitting	$ 4,205,000	
	15%	Engineering Services (Design)	$ 6,307,000	
	13%	Construction Management	$ 5,466,000	
	12%	Engineering Services During Construction	$ 5,046,000	
		Estimated Total Capital Cost	**$ 69,376,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 3,089,000**	
	Mobilization	10%		1	LS	$3,088,645	$ 3,089,000	10% of Divisions 2-17
2 - Sitework							**$ 2,500,000**	
	Allowance for Site Work			1	LS	$1,500,000	$ 1,500,000	
	Yard Piping Allowance			1	LS	$1,000,000	$ 1,000,000	
3 - Concrete							**$ 339,000**	
	Treatment Equipment							
	Slab for Catridge Filters			29	CY	$291	$ 8,000	
	Slab for Resin Vessels and Regeneration Equipment			190	CY	$291	$ 55,000	
	Chemical Storage Area							
	Wall			35	CY	$393	$ 14,000	
	Other Areas							
	Slab for Transformer			37	CY	$291	$ 11,000	
	Slab for Switchgear			19	CY	$291	$ 6,000	
	Slab for Influent Water Tank			30	CY	$291	$ 9,000	
	Slab for Influent Water Pumps			47	CY	$291	$ 14,000	
	Slab for Bypass Water Pumps			26	CY	$291	$ 8,000	
	Slab for Product Water Transfer Pumps			47	CY	$291	$ 14,000	
	Slab for Effluent Water Tank			672	CY	$291	$ 196,000	
	Slab for Effluent Water Pump Station			15	CY	$291	$ 4,000	
4 - Masonry							**$ -**	
							$ -	
5 - Metals							**$ 76,000**	
	Chain Link Fence around perimeter			1,461	LF	$52	$ 76,000	
6 - Wood and Plastic							**$ -**	
							$ -	
7 - Moisture and Thermal Protection							**$ -**	
							$ -	
8 - Doors and Windows							**$ -**	
							$ -	
9 - Finishes							**$ -**	
10 - Specialties							**$ -**	
11 - Equipment							**$ 11,938,451**	
	Treatment							
	Cartridge Filters			2	EA	$90,000	$ 180,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			1	LS	$7,150,000	$ 7,150,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pumps	65	hp	3	EA	$39,060	$ 117,181	2 duty, 1 standy by
	Water Storage Pump	40	hp	2	EA	$33,000	$ 66,000	1 duty, 1 standy by
	Bypass Water Pumps	25	hp	2	EA	$29,364	$ 58,728	1 duty, 1 standy by
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	2 duty, 1 standy by
	Raw Water Handling							
	Raw Water Pipeline	8	inch	1,431	ft	$200	$ 286,772	
	Raw Water Pipeline	10	inch	1,204	ft	$251	$ 301,602	
	Raw Water Pipeline	12	inch	2,194	ft	$301	$ 659,516	
	Raw Water Pipeline	20	inch	3,559	ft	$501	$ 1,783,059	
	Raw Water Pipeline	24	inch	580	ft	$601	$ 348,696	
	Distribution & Collection Piping							
	Distribution Lateral Connection	30	inch	1,000	ft	$752	$ 751,500	
	Sewer Lateral Piping	8	inch	100	ft	$200	$ 20,040	
12 - Furnishings							**$ -**	
							$ -	
13 - Special Construction							**$ 4,233,000**	
	Process Building							
	Process Building (Est. 240' x 140'; incl. equip. storage, elec. room, and staff facilities)			15,400	SF	$300	$ 4,620,000	
	Chemical Storage (105' x 40')			4,032	SF	$300	$ 1,210,000	
	Tanks							
	Distribution Water Tank with Storage for Nitrate Dilut	5,700,000	gallons	1	EA	$3,650,000.00	$3,650,000.00	Prestressed Concrete Tank
	Bulk Regen Salt Storage	70,500	gallons	2	EA	$2.24	$ 316,000	Steel Tank with Epoxy Coating
	Regeneration Brine Pit	50,000	gallons	1	EA	$2.22	$ 111,000	Steel Tank
	Influent Water Tank	70,000	gallons	1	EA	$2.22	$ 156,000	Steel Tank
14 - Conveying Systems							**$ -**	
15 - Mechanical							**$ 1,194,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$1,194,000	$ 1,194,000	10% of Division 11 Equipment
16 - Electrical							**$ 2,388,000**	
	Electrical Allowance	20%		1	LS	$2,388,000	$ 2,388,000	20% of Division 11 Equipment
17 - I&C							**$ 2,388,000**	
	I&C Allowance	20%		1	LS	$2,388,000	$ 2,388,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 665,000**	
Catridge Filters		18,304	Elements/year	$23	$ 426,000	changed weekly
Equipment Maintenance and Repair	2%	1	LS	$ 238,769	$ 239,000	2% of Equipment Cost
Power Costs					**$ 562,000**	
Influent Feed Pumps		786,156	kW	$0.16	$ 128,000	
Bypass Water Pumps		143,116	kW	$0.16	$ 23,000	
Regeneration Pumps		4,357	kW	$0.16	$ 1,000	
Water Storage Tank Pump		471,824	kW	$0.16	$ 77,000	
Distribution Water Pumps		2,048,511	kW	$0.16	$ 333,000	
Chemical Costs					**$ 1,530,000**	
Brine Regenerant Solution		17,000	ton	$90.00	$ 1,530,000	
		653.85				
Disposal Costs					**$ -**	
Regeneration Brine Disposal Fee			gallons	$0.05	$ -	
Regeneration Brine Hauling Fee			gallons	$0.16	$ -	
Labor					**$ 236,000**	
	Full Time Equivalents	3	person(s)			
	Total Annual Hours per Year	6,240	Labor Hours			
	Average Labor Rate	$ 38	$/hour		$ 236,000	
				TOTAL ANNUAL O&M COSTS	$ 2,993,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
Replacement Resin	7	2596	Cubic Feet	$203	$ 526,000	determine number of bed volumes
Resin Disposal Cost as Solid Waste	7	52	Tons	$43	$ 2,000	
Pump Replacement	10	100%	Pump Cost	$457,265	$ 457,000	

Project: City of Patterson Chrome 6 Treatment FS

Aspect: Centralized- SBA Treatment Expansion (Sewer Disposal)

Date: 12/5/2016

Project Number: 0603-003
Prepared By: AR
Checked By:
Check Date:

Estimate Type: Planning

Process Cost Summary by Division

Spec. Division			Subtotal	Notes
1 - General Requirements			$ 556,000	
2 - Sitework			$ -	
3 - Concrete			$ -	
5 - Metals			$ -	
9 - Finishes			$ -	
11 - Equipment			$ 3,598,000	
13 - Special Construction			$ 158,000	
15 - Mechanical			$ 360,000	
16 - Electrical			$ 720,000	
17 - Instrumentation and Control			$ 720,000	
		Raw Construction Subtotal	$ 6,112,000	
	25%	Construction Contingency	$ 1,528,000	
		Construction Cost Subtotal	**$ 7,640,000**	
	9%	Tax on Materials	$ 344,000	Percentage of materials costs (materials cost estimated as 50% of construction cost)
	15%	General Contractor Overhead and Profit	$ 1,146,000	
		Estimated Total Construction Cost	**$ 9,130,000**	
	15%	Owner's Reserve for Change Orders	$ 1,370,000	
	10%	Environmental Documents and Permitting	$ 913,000	
	15%	Engineering Services (Design)	$ 1,370,000	
	13%	Construction Management	$ 1,187,000	
	12%	Engineering Services During Construction	$ 1,096,000	
		Estimated Total Capital Cost	**$ 15,066,000**	

Item	Description	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
1 - General Requirements							**$ 556,000**	
	Mobilization	10%		1	LS	$555,572	$ 556,000	10% of Divisions 2-17
2 - Sitework							**$ -**	
3 - Concrete							**$ -**	
5 - Metals							**$ -**	
9 - Finishes							**$ -**	
11 - Equipment							**$ 3,597,720**	
	Treatment							
	Catridge Filters			0.6	LS	$90,000	$ 52,000	Vendor quotes
	SBA Resin Vessels and Regeneration Equipment			0.6	LS	$5,630,300	$ 3,202,000	Vendor quotes
	Additional Pumping Requirements							
	Process Pumps	40	hp	3	EA	$33,000	$ 99,000	1 duty, 1 standy by at each site
	Bypass Water Pumps	25	hp	1	EA	$29,364	$ 29,364	1 duty, 1 standy by at each site
	Distribution Water Pumps	200	hp	3	EA	$71,786	$ 215,357	1 duty, 1 standy by at each site
13 - Special Construction							**$ 158,000**	
	Bulk Regen Salt Storage	70,500	gallons	1	EA	$2.24	$ 158,000	Steel Tank with Epoxy Coating
15 - Mechanical							**$ 360,000**	
	Process Pipe/Fittings/Appurtenances Allowance	10%		1	LS	$360,000	$ 360,000	10% of Division 11 Equipment
16 - Electrical							**$ 720,000**	
	Electrical Allowance	20%		1	LS	$720,000	$ 720,000	20% of Division 11 Equipment
17 - I&C							**$ 720,000**	
	I&C Allowance	20%		1	LS	$720,000	$ 720,000	20% of Division 11 Equipment

ANNUAL O&M COSTS		Quantity	Unit	Value	Cost	Notes
Consumables					**$ 979,000**	
	Catridge Filters	28,712	Elements/year	$23	$ 668,000	changed weekly
	Equipment Maintenance and Repair 2%	1	LS	$ 310,954	$ 311,000	2% of Equipment Cost
Power Costs					**$ 804,000**	
	Influent Feed Pumps	1,037,894	kW	$0.16	$ 169,000	
	Bypass Water Pumps	210,173	kW	$0.16	$ 34,000	
	Regeneration Pumps	112,093	kW	$0.16	$ 18,000	
	Water Storage Tank Pump	373,642	kW	$0.16	$ 61,000	
	Distribution Water Pumps	3,213,319	kW	$0.16	$ 522,000	
Chemical Costs					**$ 2,400,000**	
	Brine Regenerant Solution	26,667	ton	$90.00	$ 2,400,000	
Disposal Costs					**$ -**	
	Regeneration Brine Disposal Fee	0	gallons	$0.05	$ -	
	Regeneration Brine Hauling Fee	0	gallons	$0.16	$ -	
Labor					**$ 236,000**	
	Full Time Equivalents	3	person(s)			
	Total Annual Hours per Year	6,240	Labor Hours			
	Average Labor Rate $	38	$/hour		$ 236,000	
				TOTAL ANNUAL O&M COSTS	$ 4,419,000	

NON-ANNUAL O&M COSTS	Reoccurance Interval (yrs)	Quantity	Unit	Value	Cost	Notes
Consumables						
Replacement Resin	7	4072	LS/Vessel	$203	$ 825,000	determine number of bed volumes
Resin Disposal Cost as Solid Waste	7	81	Tons	$43	$ 3,000	
Pump Replacement	10	100%	Pump Cost	$104,786	$ 105,000	

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	RCF Wellhead Treatment (landfill)					RO Wellhead Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 106,526,000	$ 1,149,605	$ -	**$ 107,675,605**	**$ 107,675,605**	$ 83,349,000	$ 1,446,265		**$ 84,795,265**	**$ 84,795,265**
5,045	**1**	**2018**	$ -	$ 1,200,758	$ -	$ 1,200,758	$ 1,138,159	$ -	$ 1,529,628	$ -	$ 1,529,628	$ 1,449,885
5,263	**2**	**2019**	$ -	$ 1,253,944	$ -	$ 1,253,944	$ 1,126,609		$ 1,616,692	$ -	$ 1,616,692	$ 1,452,521
5,481	**3**	**2020**	$ -	$ 1,309,242	$ -	$ 1,309,242	$ 1,114,968	$ 11,071,510	$ 1,707,603	$ 1,078,522	$ 13,857,635	$ 11,801,351
5,699	**4**	**2021**	$ -	$ 1,366,728	$ -	$ 1,366,728	$ 1,103,246	$ -	$ 1,802,514	$ -	$ 1,802,514	$ 1,455,019
5,917	**5**	**2022**	$ -	$ 1,426,486	$ 1,144,204	$ 2,570,689	$ 1,966,923	$ -	$ 1,959,445	$ 869,456	$ 2,828,900	$ 2,164,489
6,134	**6**	**2023**	$ -	$ 1,488,598	$ -	$ 1,488,598	$ 1,079,600	$ -	$ 2,062,853	$ 1,178,530	$ 3,241,383	$ 2,350,799
6,352	**7**	**2024**	$ 18,716,220	$ 1,553,154	$ -	$ 20,269,375	$ 13,933,914	$ 12,461,082	$ 2,170,702	$ -	$ 14,631,784	$ 10,058,427
6,570	**8**	**2025**	$ -	$ 1,620,243	$ -	$ 1,620,243	$ 1,055,749	$ -	$ 2,283,165	$ 178,615	$ 2,461,780	$ 1,604,093
6,788	**9**	**2026**	$ -	$ 1,689,960	$ -	$ 1,689,960	$ 1,043,769	$ -	$ 2,400,423	$ 183,973	$ 2,584,396	$ 1,596,199
7,006	**10**	**2027**	$ -	$ 1,898,343	$ 2,502,372	$ 4,400,715	$ 2,576,313	$ -	$ 2,596,992	$ 3,757,590	$ 6,354,583	$ 3,720,167
7,223	**11**	**2028**	$ -	$ 1,977,437	$ -	$ 1,977,437	$ 1,097,300	$ 14,025,058	$ 2,725,185	$ 195,177	$ 16,945,419	$ 9,403,191
7,441	**12**	**2029**	$ 21,697,229	$ 2,059,567	$ -	$ 23,756,797	$ 12,495,636	$ -	$ 2,858,731	$ 1,407,226	$ 4,265,957	$ 2,243,815
7,659	**13**	**2030**	$ -	$ 2,144,847	$ -	$ 2,144,847	$ 1,069,336	$ -	$ 2,997,837	$ 207,063	$ 3,204,901	$ 1,597,837
7,877	**14**	**2031**	$ -	$ 2,233,389	$ -	$ 2,233,389	$ 1,055,431	$ -	$ 3,142,717	$ 213,275	$ 3,355,993	$ 1,585,939
8,095	**15**	**2032**	$ -	$ 2,483,991	$ 1,757,387	$ 4,241,378	$ 1,899,853	$ 15,785,326	$ 3,386,127	$ 3,996,186	$ 23,167,639	$ 10,377,551
8,312	**16**	**2033**	$ -	$ 2,583,959	$ -	$ 2,583,959	$ 1,097,100	$ -	$ 3,544,723	$ 226,264	$ 3,770,987	$ 1,601,090
8,530	**17**	**2034**	$ 25,153,035	$ 2,687,689	$ -	$ 27,840,724	$ 11,204,403	$ -	$ 3,709,788	$ 233,052	$ 3,942,840	$ 1,586,782
8,748	**18**	**2035**	$ -	$ 2,795,317	$ -	$ 2,795,317	$ 1,066,318	$ -	$ 3,881,567	$ 1,920,344	$ 5,801,911	$ 2,213,231
8,965	**19**	**2036**	$ -	$ 2,906,857	$ -	$ 2,906,857	$ 1,051,059	$ 17,766,523	$ 4,060,027	$ 247,244	$ 22,073,795	$ 7,981,422
9,183	**20**	**2037**	$ -	$ 3,207,647	$ 4,098,066	$ 7,305,713	$ 2,503,879	$ -	$ 4,359,055	$ 6,767,499	$ 11,126,554	$ 3,813,392
9,400	**21**	**2038**	$ -	$ 3,333,174	$ -	$ 3,333,174	$ 1,082,820	$ -	$ 4,554,755	$ 2,098,412	$ 6,653,167	$ 2,161,358
9,618	**22**	**2039**	$ 29,159,262	$ 3,463,346	$ -	$ 32,622,608	$ 10,045,338	$ -	$ 4,758,274	$ 270,171	$ 5,028,445	$ 1,548,387
9,836	**23**	**2040**	$ -	$ 3,598,329	$ -	$ 3,598,329	$ 1,050,254	$ 19,996,379	$ 4,969,905	$ 556,551	$ 25,522,835	$ 7,449,418
10,054	**24**	**2041**	$ -	$ 3,738,294	$ -	$ 3,738,294	$ 1,034,224	$ -	$ 5,189,951	$ 2,292,992	$ 7,482,943	$ 2,070,205
10,272	**25**	**2042**	$ -	$ 4,098,743	$ 3,213,949	$ 7,312,693	$ 1,917,634	$ -	$ 5,555,184	$ 4,704,719	$ 10,259,903	$ 2,690,492
10,489	**26**	**2043**	$ -	$ 4,255,480	$ -	$ 4,255,480	$ 1,057,754	$ -	$ 5,796,020	$ 608,159	$ 6,404,179	$ 1,591,840
10,707	**27**	**2044**	$ 33,803,576	$ 4,417,932	$ -	$ 38,221,508	$ 9,005,159	$ 22,506,100	$ 6,046,306	$ 2,505,614	$ 31,058,020	$ 7,317,410
10,925	**28**	**2045**	$ -	$ 4,586,301	$ -	$ 4,586,301	$ 1,024,221	$ -	$ 6,306,393	$ 645,196	$ 6,951,589	$ 1,552,441
11,143	**29**	**2046**	$ -	$ 4,760,796	$ -	$ 4,760,796	$ 1,007,763	$ -	$ 6,736,197	$ 664,551	$ 7,400,749	$ 1,566,586
11,361	**30**	**2047**	$ -	$ 5,192,141	$ 6,495,354	$ 11,687,495	$ 2,345,026	$ -	$ 7,020,763	$ 12,087,767	$ 19,108,530	$ 3,834,012
11,578	**31**	**2048**	$ -	$ 5,386,877	$ -	$ 5,386,877	$ 1,024,497	$ -	$ 7,316,341	$ 705,023	$ 8,021,364	$ 1,525,534
11,796	**32**	**2049**	$ 39,187,609	$ 5,588,624	$ -	$ 44,776,233	$ 8,071,771	$ 26,090,738	$ 7,623,334	$ 726,173	$ 34,440,246	$ 6,208,512
12,014	**33**	**2050**	$ -	$ 5,797,628	$ -	$ 5,797,628	$ 990,648	$ -	$ 7,942,163	$ 3,365,813	$ 11,307,976	$ 1,932,207
286,309		**Total:**	$ 274,242,932	$ 99,255,426	$ 19,211,333	$ 392,709,691	$ 208,012,280	$ 223,051,716	$ 136,057,628	$ 53,891,156	$ 413,000,500	$ 206,300,870

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	SBA Wellhead Treatment (liquid haul)					WBA Wellhead Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 65,177,000	$ 4,509,262	$ -	**$ 69,686,262**	**$ 69,686,262**	$ 70,924,000	$ 1,353,612	$ -	**$ 72,277,612**	**$ 72,277,612**
5,045	**1**	**2018**	$ -	$ 4,813,839	$ -	$ 4,813,839	$ 4,562,880	$ -	$ 1,414,324	$ -	$ 1,414,324	$ 1,340,591
5,263	**2**	**2019**	$ -	$ 5,132,632	$ -	$ 5,132,632	$ 4,611,425	$ -	$ 1,477,459	$ 3,304,704	$ 4,782,163	$ 4,296,546
5,481	**3**	**2020**	$ -	$ 5,466,220	$ -	$ 5,466,220	$ 4,655,108	$ -	$ 1,543,111	$ -	$ 1,543,111	$ 1,314,134
5,699	**4**	**2021**	$ -	$ 5,815,204	$ -	$ 5,815,204	$ 4,694,130	$ -	$ 1,611,371	$ -	$ 1,611,371	$ 1,300,726
5,917	**5**	**2022**	$ -	$ 6,180,208	$ -	$ 6,180,208	$ 4,728,689	$ -	$ 1,682,338	$ 3,611,139	$ 5,293,477	$ 4,050,221
6,134	**6**	**2023**	$ -	$ 6,561,878	$ -	$ 6,561,878	$ 4,758,975	$ -	$ 1,756,113	$ -	$ 1,756,113	$ 1,273,614
6,352	**7**	**2024**	$ 11,451,356	$ 6,960,886	$ 742,282	$ 19,154,523	$ 13,167,524	$ 12,461,082	$ 1,832,801	$ -	$ 14,293,883	$ 9,826,141
6,570	**8**	**2025**	$ -	$ 7,377,929	$ -	$ 7,377,929	$ 4,807,450	$ -	$ 1,912,509	$ 3,945,989	$ 5,858,498	$ 3,817,391
6,788	**9**	**2026**	$ -	$ 7,813,729	$ -	$ 7,813,729	$ 4,825,988	$ -	$ 1,995,351	$ -	$ 1,995,351	$ 1,232,387
7,006	**10**	**2027**	$ -	$ 8,355,431	$ 1,173,365	$ 9,528,796	$ 5,578,449	$ -	$ 2,270,861	$ 5,359,665	$ 7,630,526	$ 4,467,143
7,223	**11**	**2028**	$ -	$ 8,830,833	$ -	$ 8,830,833	$ 4,900,322	$ -	$ 2,365,700	$ -	$ 2,365,700	$ 1,312,752
7,441	**12**	**2029**	$ 13,275,260	$ 9,327,238	$ -	$ 22,602,498	$ 11,888,496	$ 14,445,809	$ 2,464,186	$ 634,464	$ 17,544,459	$ 9,228,061
7,659	**13**	**2030**	$ -	$ 9,845,481	$ -	$ 9,845,481	$ 4,908,570	$ -	$ 2,566,451	$ 4,574,483	$ 7,140,934	$ 3,560,189
7,877	**14**	**2031**	$ -	$ 10,386,423	$ 912,913	$ 11,299,336	$ 5,339,720	$ -	$ 2,672,635	$ -	$ 2,672,635	$ 1,263,006
8,095	**15**	**2032**	$ -	$ 11,063,283	$ -	$ 11,063,283	$ 4,955,610	$ -	$ 3,003,779	$ 693,296	$ 3,697,075	$ 1,656,042
8,312	**16**	**2033**	$ -	$ 11,653,258	$ -	$ 11,653,258	$ 4,947,753	$ -	$ 3,124,592	$ 4,998,661	$ 8,123,253	$ 3,448,979
8,530	**17**	**2034**	$ 15,389,664	$ 12,268,674	$ 142,509	$ 27,800,848	$ 11,188,355	$ 16,746,652	$ 3,249,951	$ 735,517	$ 20,732,120	$ 8,343,570
8,748	**18**	**2035**	$ -	$ 12,910,528	$ -	$ 12,910,528	$ 4,924,926	$ -	$ 3,380,018	$ 6,060,662	$ 9,440,680	$ 3,601,298
8,965	**19**	**2036**	$ -	$ 13,578,556	$ -	$ 13,578,556	$ 4,909,722	$ -	$ 3,514,811	$ -	$ 3,514,811	$ 1,270,882
9,183	**20**	**2037**	$ -	$ 14,417,668	$ 1,802,177	$ 16,219,845	$ 5,559,011	$ -	$ 3,912,086	$ 3,649,829	$ 7,561,915	$ 2,591,687
9,400	**21**	**2038**	$ -	$ 15,147,139	$ 1,122,768	$ 16,269,907	$ 5,285,468	$ -	$ 4,064,793	$ 5,794,818	$ 9,859,611	$ 3,203,009
9,618	**22**	**2039**	$ 17,840,839	$ 15,907,402	$ 165,207	$ 33,913,449	$ 10,442,821	$ 19,413,960	$ 4,223,142	$ 852,666	$ 24,489,768	$ 7,541,028
9,836	**23**	**2040**	$ -	$ 16,699,649	$ -	$ 16,699,649	$ 4,874,171	$ -	$ 4,387,333	$ 1,756,492	$ 6,143,825	$ 1,793,215
10,054	**24**	**2041**	$ -	$ 17,525,115	$ 175,268	$ 17,700,383	$ 4,896,927	$ -	$ 4,557,575	$ 6,332,154	$ 10,889,728	$ 3,012,715
10,272	**25**	**2042**	$ -	$ 18,559,198	$ 261,152	$ 18,820,351	$ 4,935,330	$ -	$ 5,033,456	$ 2,124,615	$ 7,158,070	$ 1,877,087
10,489	**26**	**2043**	$ -	$ 19,458,114	$ -	$ 19,458,114	$ 4,836,562	$ -	$ 5,225,204	$ 959,683	$ 6,184,887	$ 1,537,332
10,707	**27**	**2044**	$ 20,682,422	$ 20,394,262	$ 191,521	$ 41,268,205	$ 9,722,975	$ 22,506,100	$ 5,423,927	$ 7,907,789	$ 35,837,816	$ 8,443,551
10,925	**28**	**2045**	$ -	$ 21,369,066	$ 1,380,863	$ 22,749,930	$ 5,080,555	$ -	$ 5,629,870	$ 3,054,383	$ 8,684,254	$ 1,939,383
11,143	**29**	**2046**	$ -	$ 22,384,004	$ 203,184	$ 22,587,188	$ 4,781,243	$ -	$ 5,843,289	$ 7,340,702	$ 13,183,990	$ 2,790,780
11,361	**30**	**2047**	$ -	$ 23,652,312	$ 2,724,722	$ 26,377,034	$ 5,292,394	$ -	$ 6,412,570	$ 4,931,104	$ 11,343,674	$ 2,276,040
11,578	**31**	**2048**	$ -	$ 24,756,513	$ 215,558	$ 24,972,071	$ 4,749,286	$ -	$ 6,651,961	$ 3,337,607	$ 9,989,569	$ 1,899,855
11,796	**32**	**2049**	$ 23,976,596	$ 25,905,679	$ 222,025	$ 50,104,299	$ 9,032,257	$ 26,090,738	$ 6,899,945	$ 8,021,383	$ 41,012,067	$ 7,393,208
12,014	**33**	**2050**	$ -	$ 27,101,514	$ -	$ 27,101,514	$ 4,630,868	$ -	$ 7,156,821	$ 3,540,868	$ 10,697,689	$ 1,827,927
286,309		**Total:**	$ 167,793,136	$ 452,129,127	$ 11,435,516	$ 631,357,779	$ 268,160,222	$ 182,588,342	$ 120,613,946	$ 93,522,668	$ 396,724,956	$ 187,008,101

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	RCF Centralized Treatment (landfill)					RO Centralized Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 128,590,000	$ 1,200,915		**$ 129,790,915**	**$ 129,790,915**	$ 95,742,000	$ 1,717,393		**$ 97,459,393**	**$ 97,459,393**
5,045	**1**	**2018**	$ -	$ 1,256,828		$ 1,256,828	$ 1,191,306	$ -	$ 1,809,639		$ 1,809,639	$ 1,715,298
5,263	**2**	**2019**	$ -	$ 1,315,014		$ 1,315,014	$ 1,181,477	$ -	$ 1,905,876		$ 1,905,876	$ 1,712,338
5,481	**3**	**2020**	$ -	$ 1,375,560	$ 910,242	$ 2,285,802	$ 1,946,620	$ -	$ 2,006,257	$ 910,242	$ 2,916,499	$ 2,483,730
5,699	**4**	**2021**	$ -	$ 1,438,556		$ 1,438,556	$ 1,161,226	$ -	$ 2,110,946		$ 2,110,946	$ 1,703,991
5,917	**5**	**2022**	$ -	$ 1,504,093		$ 1,504,093	$ 1,150,833	$ -	$ 2,220,111	$ 1,139,566	$ 3,359,678	$ 2,570,605
6,134	**6**	**2023**	$ -	$ 1,572,268	$ 994,646	$ 2,566,913	$ 1,861,643	$ -	$ 2,333,926	$ 994,646	$ 3,328,572	$ 2,414,033
6,352	**7**	**2024**	$ -	$ 1,643,179		$ 1,643,179	$ 1,129,582	$ -	$ 2,452,572		$ 2,452,572	$ 1,685,988
6,570	**8**	**2025**	$ -	$ 1,716,930		$ 1,716,930	$ 1,118,750	$ -	$ 2,576,236		$ 2,576,236	$ 1,678,672
6,788	**9**	**2026**	$ -	$ 1,793,628	$ 1,086,876	$ 2,880,504	$ 1,779,083	$ -	$ 2,705,112	$ 1,086,876	$ 3,791,988	$ 2,342,043
7,006	**10**	**2027**	$ -	$ 1,873,382	$ 634,329	$ 2,507,710	$ 1,468,090	$ -	$ 2,839,403	$ 1,629,516	$ 4,468,919	$ 2,616,242
7,223	**11**	**2028**	$ -	$ 1,956,307		$ 1,956,307	$ 1,085,575	$ -	$ 2,979,316		$ 2,979,316	$ 1,653,254
7,441	**12**	**2029**	$ -	$ 2,042,521	$ 1,187,659	$ 3,230,180	$ 1,699,015	$ -	$ 3,125,068	$ 1,187,659	$ 4,312,727	$ 2,268,415
7,659	**13**	**2030**	$ 62,330,445	$ 2,132,148		$ 64,462,593	$ 32,138,514	$ 33,569,212	$ 3,276,885		$ 36,846,097	$ 18,370,015
7,877	**14**	**2031**	$ -	$ 2,539,878		$ 2,539,878	$ 1,200,269	$ -	$ 3,535,353		$ 3,535,353	$ 1,670,699
8,095	**15**	**2032**	$ -	$ 2,646,107		$ 2,646,107	$ 1,185,279	$ -	$ 3,702,985		$ 3,702,985	$ 1,658,690
8,312	**16**	**2033**	$ -	$ 2,756,425	$ 2,095,747	$ 4,852,171	$ 2,060,140	$ -	$ 3,877,494	$ 2,095,747	$ 5,973,241	$ 2,536,125
8,530	**17**	**2034**	$ -	$ 2,870,979		$ 2,870,979	$ 1,155,416	$ -	$ 4,059,141		$ 4,059,141	$ 1,633,587
8,748	**18**	**2035**	$ -	$ 2,989,926		$ 2,989,926	$ 1,140,555	$ -	$ 4,248,197	$ 2,625,152	$ 6,873,349	$ 2,621,948
8,965	**19**	**2036**	$ -	$ 3,113,271	$ 2,290,079	$ 5,403,350	$ 1,953,738	$ -	$ 4,444,625	$ 2,290,079	$ 6,734,704	$ 2,435,128
9,183	**20**	**2037**	$ -	$ 3,241,486	$ 852,485	$ 4,093,970	$ 1,403,122	$ -	$ 4,649,343	$ 414,526	$ 5,063,869	$ 1,735,535
9,400	**21**	**2038**	$ -	$ 3,374,591		$ 3,374,591	$ 1,096,275	$ -	$ 4,862,344		$ 4,862,344	$ 1,579,589
9,618	**22**	**2039**	$ -	$ 3,512,766	$ 2,502,431	$ 6,015,197	$ 1,852,234	$ -	$ 5,083,940	$ 2,502,431	$ 7,586,371	$ 2,336,038
9,836	**23**	**2040**	$ -	$ 3,656,194	$ 207,227	$ 3,863,420	$ 1,127,627	$ -	$ 5,314,456	$ 3,501,142	$ 8,815,599	$ 2,573,032
10,054	**24**	**2041**	$ -	$ 3,805,066		$ 3,805,066	$ 1,052,696	$ -	$ 5,554,228		$ 5,554,228	$ 1,536,614
10,272	**25**	**2042**	$ -	$ 3,959,580	$ 2,734,474	$ 6,694,054	$ 1,755,406	$ -	$ 5,803,602	$ 2,734,474	$ 8,538,076	$ 2,238,971
10,489	**26**	**2043**	$ -	$ 4,119,940		$ 4,119,940	$ 1,024,064	$ -	$ 6,062,941		$ 6,062,941	$ 1,507,021
10,707	**27**	**2044**	$ -	$ 4,286,358		$ 4,286,358	$ 1,009,885	$ -	$ 6,332,617		$ 6,332,617	$ 1,491,993
10,925	**28**	**2045**	$ -	$ 4,459,053	$ 2,988,034	$ 7,447,086	$ 1,663,097	$ -	$ 6,613,016	$ 6,516,018	$ 13,129,034	$ 2,932,000
11,143	**29**	**2046**	$ -	$ 4,638,252		$ 4,638,252	$ 981,823	$ -	$ 6,904,540		$ 6,904,540	$ 1,461,549
11,361	**30**	**2047**	$ -	$ 4,824,190	$ 1,145,668	$ 5,969,858	$ 1,197,816	$ -	$ 7,207,604	$ 557,089	$ 7,764,693	$ 1,557,939
11,578	**31**	**2048**	$ -	$ 5,017,110	$ 3,265,105	$ 8,282,214	$ 1,575,144	$ -	$ 7,522,637	$ 3,265,105	$ 10,787,742	$ 2,051,655
11,796	**32**	**2049**	$ -	$ 5,217,263		$ 5,217,263	$ 940,511	$ -	$ 7,850,086		$ 7,850,086	$ 1,415,128
12,014	**33**	**2050**	$ -	$ 5,424,910	$ 1,530,397	$ 6,955,307	$ 1,188,462	$ -	$ 8,190,411	$ 4,705,243	$ 12,895,654	$ 2,203,496
286,309		**Total:**	$ 190,920,445	$ 99,274,671	$ 24,425,396	$ 314,620,512	$ 205,266,188	$ 129,311,212	$ 145,878,299	$ 38,155,511	$ 313,345,022	$ 179,850,753

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	SBA Centralized Treatment (liquid haul)					WBA Centralized Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 69,376,000	$ 4,069,745		**$ 73,445,745**	**$ 73,445,745**	$ 69,250,000	$ 1,303,529		**$ 70,553,529**	**$ 70,553,529**
5,045	**1**	**2018**	$ -	$ 4,339,086		$ 4,339,086	$ 4,112,878	$ -	$ 1,363,756	$ 2,056,910	$ 3,420,666	$ 3,242,338
5,263	**2**	**2019**	$ -	$ 4,620,925		$ 4,620,925	$ 4,151,681	$ -	$ 1,426,424		$ 1,426,424	$ 1,281,574
5,481	**3**	**2020**	$ -	$ 4,915,768		$ 4,915,768	$ 4,186,335	$ -	$ 1,491,625	$ 2,182,176	$ 3,673,800	$ 3,128,659
5,699	**4**	**2021**	$ -	$ 5,224,144		$ 5,224,144	$ 4,217,016	$ -	$ 1,559,453		$ 1,559,453	$ 1,258,817
5,917	**5**	**2022**	$ -	$ 5,546,598		$ 5,546,598	$ 4,243,892	$ -	$ 1,630,009	$ 2,315,070	$ 3,945,080	$ 3,018,516
6,134	**6**	**2023**	$ -	$ 5,883,697		$ 5,883,697	$ 4,267,127	$ -	$ 1,703,395		$ 1,703,395	$ 1,235,380
6,352	**7**	**2024**	$ -	$ 6,236,031	$ 649,373	$ 6,885,404	$ 4,733,280	$ -	$ 1,779,717	$ 2,456,058	$ 4,235,776	$ 2,911,828
6,570	**8**	**2025**	$ -	$ 6,604,209		$ 6,604,209	$ 4,303,295	$ -	$ 1,859,086		$ 1,859,086	$ 1,211,378
6,788	**9**	**2026**	$ -	$ 6,988,865		$ 6,988,865	$ 4,316,528	$ -	$ 1,941,614	$ 2,605,632	$ 4,547,246	$ 2,808,512
7,006	**10**	**2027**	$ -	$ 7,390,657	$ 614,170	$ 8,004,827	$ 4,686,270	$ -	$ 2,027,422	$ 3,322,161	$ 5,349,583	$ 3,131,809
7,223	**11**	**2028**	$ -	$ 7,810,266		$ 7,810,266	$ 4,333,999	$ -	$ 2,116,630		$ 2,116,630	$ 1,174,540
7,441	**12**	**2029**	$ -	$ 8,248,401		$ 8,248,401	$ 4,338,506	$ -	$ 2,209,366	$ 2,847,244	$ 5,056,610	$ 2,659,684
7,659	**13**	**2030**	$ 22,124,929	$ 8,705,794	$ 775,386	$ 31,606,109	$ 15,757,563	$ 61,494,849	$ 2,305,761	$ 298,112	$ 64,098,723	$ 31,957,103
7,877	**14**	**2031**	$ -	$ 9,614,982		$ 9,614,982	$ 4,543,746	$ -	$ 3,063,756	$ 4,738,944	$ 7,802,699	$ 3,687,317
8,095	**15**	**2032**	$ -	$ 10,124,929		$ 10,124,929	$ 4,535,290	$ -	$ 3,187,569		$ 3,187,569	$ 1,427,817
8,312	**16**	**2033**	$ -	$ 10,656,819		$ 10,656,819	$ 4,524,684	$ -	$ 3,316,053	$ 5,027,545	$ 8,343,598	$ 3,542,534
8,530	**17**	**2034**	$ -	$ 11,211,509		$ 11,211,509	$ 4,512,033	$ -	$ 3,449,377		$ 3,449,377	$ 1,388,190
8,748	**18**	**2035**	$ -	$ 11,789,890		$ 11,789,890	$ 4,497,441	$ -	$ 3,587,717	$ 5,333,723	$ 8,921,440	$ 3,403,225
8,965	**19**	**2036**	$ -	$ 12,391,739		$ 12,391,739	$ 4,480,593	$ -	$ 3,731,087		$ 3,731,087	$ 1,349,083
9,183	**20**	**2037**	$ -	$ 13,020,267	$ 2,320,853	$ 15,341,120	$ 5,257,846	$ -	$ 3,880,001	$ 6,516,449	$ 10,396,451	$ 3,563,165
9,400	**21**	**2038**	$ -	$ 13,675,354		$ 13,675,354	$ 4,442,597	$ -	$ 4,034,492		$ 4,034,492	$ 1,310,651
9,618	**22**	**2039**	$ -	$ 14,358,028		$ 14,358,028	$ 4,421,205	$ -	$ 4,194,760	$ 6,003,152	$ 10,197,912	$ 3,140,199
9,836	**23**	**2040**	$ -	$ 15,069,354	$ 207,227	$ 15,276,581	$ 4,458,816	$ -	$ 4,361,013	$ 6,436,042	$ 10,797,054	$ 3,151,365
10,054	**24**	**2041**	$ -	$ 15,810,438		$ 15,810,438	$ 4,374,061	$ -	$ 4,533,466		$ 4,533,466	$ 1,254,213
10,272	**25**	**2042**	$ -	$ 16,582,425		$ 16,582,425	$ 4,348,471	$ -	$ 4,712,341	$ 6,559,806	$ 11,272,147	$ 2,955,937
10,489	**26**	**2043**	$ -	$ 17,386,501		$ 17,386,501	$ 4,321,637	$ -	$ 4,897,868		$ 4,897,868	$ 1,217,428
10,707	**27**	**2044**	$ -	$ 18,223,898	$ 1,839,227	$ 20,063,125	$ 4,726,963	$ -	$ 5,090,287	$ 6,959,298	$ 12,049,585	$ 2,838,936
10,925	**28**	**2045**	$ -	$ 19,095,891		$ 19,095,891	$ 4,264,529	$ -	$ 5,289,842		$ 5,289,842	$ 1,181,337
11,143	**29**	**2046**	$ -	$ 20,003,801		$ 20,003,801	$ 4,234,393	$ -	$ 5,496,789	$ 7,383,120	$ 12,879,909	$ 2,726,412
11,361	**30**	**2047**	$ -	$ 20,949,000	$ 1,109,259	$ 22,058,259	$ 4,425,858	$ -	$ 5,711,392	$ 1,152,950	$ 6,864,342	$ 1,377,289
11,578	**31**	**2048**	$ -	$ 21,932,908		$ 21,932,908	$ 4,171,286	$ -	$ 5,933,924	$ 7,832,752	$ 13,766,676	$ 2,618,200
11,796	**32**	**2049**	$ -	$ 22,956,996		$ 22,956,996	$ 4,138,437	$ -	$ 6,164,668	$ 8,067,734	$ 14,232,402	$ 2,565,662
12,014	**33**	**2050**	$ -	$ 24,022,790	$ 278,495	$ 24,301,285	$ 4,152,389	$ -	$ 6,403,916	$ 444,956	$ 6,848,872	$ 1,170,275
286,309		**Total:**	$ 91,500,929	$ 405,461,706	$ 7,793,990	$ 504,756,625	$ 229,926,392	$ 130,744,849	$ 115,758,104	$ 90,539,835	$ 337,042,788	$ 175,442,902

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	RCF Wellhead Treatment (sewer)					RO Wellhead Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 99,848,000	$ 1,112,355	$ -	**$ 100,960,355**	**$ 100,960,355**	$ 83,349,000	$ 1,446,265		**$ 84,795,265**	**$ 84,795,265**
5,045	**1**	**2018**	$ -	$ 1,161,959	$ -	$ 1,161,959	$ 1,101,383	$ -	$ 1,529,628	$ -	$ 1,529,628	$ 1,449,885
5,263	**2**	**2019**	$ -	$ 1,213,539	$ -	$ 1,213,539	$ 1,090,307		$ 1,616,692	$ -	$ 1,616,692	$ 1,452,521
5,481	**3**	**2020**	$ -	$ 1,267,169	$ -	$ 1,267,169	$ 1,079,138	$ 11,071,510	$ 1,707,603	$ 1,078,522	$ 13,857,635	$ 11,801,351
5,699	**4**	**2021**	$ -	$ 1,322,923	$ -	$ 1,322,923	$ 1,067,886	$ -	$ 1,802,514	$ -	$ 1,802,514	$ 1,455,019
5,917	**5**	**2022**	$ -	$ 1,380,883	$ 1,144,204	$ 2,525,086	$ 1,932,030	$ -	$ 1,959,445	$ 869,456	$ 2,828,900	$ 2,164,489
6,134	**6**	**2023**	$ -	$ 1,441,129	$ -	$ 1,441,129	$ 1,045,173	$ -	$ 2,062,853	$ 1,178,530	$ 3,241,383	$ 2,350,799
6,352	**7**	**2024**	$ 17,542,921	$ 1,503,747	$ -	$ 19,046,668	$ 13,093,381	$ 12,461,082	$ 2,170,702	$ -	$ 14,631,784	$ 10,058,427
6,570	**8**	**2025**	$ -	$ 1,568,826	$ -	$ 1,568,826	$ 1,022,245	$ -	$ 2,283,165	$ 178,615	$ 2,461,780	$ 1,604,093
6,788	**9**	**2026**	$ -	$ 1,636,455	$ -	$ 1,636,455	$ 1,010,723	$ -	$ 2,400,423	$ 183,973	$ 2,584,396	$ 1,596,199
7,006	**10**	**2027**	$ -	$ 1,837,499	$ 2,502,372	$ 4,339,871	$ 2,540,693	$ -	$ 2,596,992	$ 3,757,590	$ 6,354,583	$ 3,720,167
7,223	**11**	**2028**	$ -	$ 1,914,196	$ -	$ 1,914,196	$ 1,062,208	$ 14,025,058	$ 2,725,185	$ 195,177	$ 16,945,419	$ 9,403,191
7,441	**12**	**2029**	$ 20,337,053	$ 1,993,841	$ -	$ 22,330,895	$ 11,745,638	$ -	$ 2,858,731	$ 1,407,226	$ 4,265,957	$ 2,243,815
7,659	**13**	**2030**	$ -	$ 2,076,543	$ -	$ 2,076,543	$ 1,035,283	$ -	$ 2,997,837	$ 207,063	$ 3,204,901	$ 1,597,837
7,877	**14**	**2031**	$ -	$ 2,162,412	$ -	$ 2,162,412	$ 1,021,889	$ -	$ 3,142,717	$ 213,275	$ 3,355,993	$ 1,585,939
8,095	**15**	**2032**	$ -	$ 2,404,217	$ 1,757,387	$ 4,161,604	$ 1,864,120	$ 15,785,326	$ 3,386,127	$ 3,996,186	$ 23,167,639	$ 10,377,551
8,312	**16**	**2033**	$ -	$ 2,501,135	$ -	$ 2,501,135	$ 1,061,935	$ -	$ 3,544,723	$ 226,264	$ 3,770,987	$ 1,601,090
8,530	**17**	**2034**	$ 23,576,219	$ 2,601,704	$ -	$ 26,177,923	$ 10,535,214	$ -	$ 3,709,788	$ 233,052	$ 3,942,840	$ 1,586,782
8,748	**18**	**2035**	$ -	$ 2,706,056	$ -	$ 2,706,056	$ 1,032,268	$ -	$ 3,881,567	$ 1,920,344	$ 5,801,911	$ 2,213,231
8,965	**19**	**2036**	$ -	$ 2,814,204	$ -	$ 2,814,204	$ 1,017,557	$ 17,766,523	$ 4,060,027	$ 247,244	$ 22,073,795	$ 7,981,422
9,183	**20**	**2037**	$ -	$ 3,104,466	$ 4,098,066	$ 7,202,532	$ 2,468,516	$ -	$ 4,359,055	$ 6,767,499	$ 11,126,554	$ 3,813,392
9,400	**21**	**2038**	$ -	$ 3,226,142	$ -	$ 3,226,142	$ 1,048,050	$ -	$ 4,554,755	$ 2,098,412	$ 6,653,167	$ 2,161,358
9,618	**22**	**2039**	$ 27,331,299	$ 3,352,325	$ -	$ 30,683,624	$ 9,448,275	$ -	$ 4,758,274	$ 270,171	$ 5,028,445	$ 1,548,387
9,836	**23**	**2040**	$ -	$ 3,483,175	$ -	$ 3,483,175	$ 1,016,644	$ 19,996,379	$ 4,969,905	$ 556,551	$ 25,522,835	$ 7,449,418
10,054	**24**	**2041**	$ -	$ 3,618,859	$ -	$ 3,618,859	$ 1,001,181	$ -	$ 5,189,951	$ 2,292,992	$ 7,482,943	$ 2,070,205
10,272	**25**	**2042**	$ -	$ 3,966,725	$ 3,213,949	$ 7,180,674	$ 1,883,015	$ -	$ 5,555,184	$ 4,704,719	$ 10,259,903	$ 2,690,492
10,489	**26**	**2043**	$ -	$ 4,118,629	$ -	$ 4,118,629	$ 1,023,738	$ -	$ 5,796,020	$ 608,159	$ 6,404,179	$ 1,591,840
10,707	**27**	**2044**	$ 31,684,466	$ 4,276,078	$ -	$ 35,960,545	$ 8,472,466	$ 22,506,100	$ 6,046,306	$ 2,505,614	$ 31,058,020	$ 7,317,410
10,925	**28**	**2045**	$ -	$ 4,439,268	$ -	$ 4,439,268	$ 991,385	$ -	$ 6,306,393	$ 645,196	$ 6,951,589	$ 1,552,441
11,143	**29**	**2046**	$ -	$ 4,608,400	$ -	$ 4,608,400	$ 975,503	$ -	$ 6,736,197	$ 664,551	$ 7,400,749	$ 1,566,586
11,361	**30**	**2047**	$ -	$ 5,024,720	$ 6,495,354	$ 11,520,074	$ 2,311,434	$ -	$ 7,020,763	$ 12,087,767	$ 19,108,530	$ 3,834,012
11,578	**31**	**2048**	$ -	$ 5,213,428	$ -	$ 5,213,428	$ 991,510	$ -	$ 7,316,341	$ 705,023	$ 8,021,364	$ 1,525,534
11,796	**32**	**2049**	$ 36,730,980	$ 5,408,936	$ -	$ 42,139,917	$ 7,596,525	$ 26,090,738	$ 7,623,334	$ 726,173	$ 34,440,246	$ 6,208,512
12,014	**33**	**2050**	$ -	$ 5,611,483	$ -	$ 5,611,483	$ 958,841	$ -	$ 7,942,163	$ 3,365,813	$ 11,307,976	$ 1,932,207
286,309		**Total:**	$ 257,050,939	$ 96,073,424	$ 19,211,333	$ 372,335,696	$ 196,506,508	$ 223,051,716	$ 136,057,628	$ 53,891,156	$ 413,000,500	$ 206,300,870

Potable Water Demand (AFY)	Year of Life Cycle Cost	Date	SBA Wellhead Treatment (sewer)					WBA Wellhead Treatment				
			Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value	Capital Costs	Routine Annual O&M Costs	Non-Routine O&M/ Equipment Replacement Costs	Subtotal	Present Value
4,828	**0**	**2017**	$ 65,177,000	$ 1,600,683	$ -	**$ 66,777,683**	**$ 66,777,683**	$ 70,924,000	$ 1,353,612	$ -	**$ 72,277,612**	**$ 72,277,612**
5,045	**1**	**2018**	$ -	$ 1,682,844	$ -	$ 1,682,844	$ 1,595,113	$ -	$ 1,414,324	$ -	$ 1,414,324	$ 1,340,591
5,263	**2**	**2019**	$ -	$ 1,768,493	$ -	$ 1,768,493	$ 1,588,907	$ -	$ 1,477,459	$ 3,304,704	$ 4,782,163	$ 4,296,546
5,481	**3**	**2020**	$ -	$ 1,857,767	$ -	$ 1,857,767	$ 1,582,100	$ -	$ 1,543,111	$ -	$ 1,543,111	$ 1,314,134
5,699	**4**	**2021**	$ -	$ 1,950,806	$ -	$ 1,950,806	$ 1,574,723	$ -	$ 1,611,371	$ -	$ 1,611,371	$ 1,300,726
5,917	**5**	**2022**	$ -	$ 2,047,755	$ -	$ 2,047,755	$ 1,566,808	$ -	$ 1,682,338	$ 3,611,139	$ 5,293,477	$ 4,050,221
6,134	**6**	**2023**	$ -	$ 2,148,766	$ -	$ 2,148,766	$ 1,558,383	$ -	$ 1,756,113	$ -	$ 1,756,113	$ 1,273,614
6,352	**7**	**2024**	$ 11,451,356	$ 2,253,994	$ 742,282	$ 14,447,631	$ 9,931,833	$ 12,461,082	$ 1,832,801	$ -	$ 14,293,883	$ 9,826,141
6,570	**8**	**2025**	$ -	$ 2,363,601	$ -	$ 2,363,601	$ 1,540,120	$ -	$ 1,912,509	$ 3,945,989	$ 5,858,498	$ 3,817,391
6,788	**9**	**2026**	$ -	$ 2,477,757	$ -	$ 2,477,757	$ 1,530,335	$ -	$ 1,995,351	$ -	$ 1,995,351	$ 1,232,387
7,006	**10**	**2027**	$ -	$ 2,752,461	$ 1,173,365	$ 3,925,827	$ 2,298,299	$ -	$ 2,270,861	$ 5,359,665	$ 7,630,526	$ 4,467,143
7,223	**11**	**2028**	$ -	$ 2,880,355	$ -	$ 2,880,355	$ 1,598,339	$ -	$ 2,365,700	$ -	$ 2,365,700	$ 1,312,752
7,441	**12**	**2029**	$ 13,275,260	$ 3,013,445	$ -	$ 16,288,705	$ 8,567,558	$ 14,445,809	$ 2,464,186	$ 634,464	$ 17,544,459	$ 9,228,061
7,659	**13**	**2030**	$ -	$ 3,151,928	$ -	$ 3,151,928	$ 1,571,427	$ -	$ 2,566,451	$ 4,574,483	$ 7,140,934	$ 3,560,189
7,877	**14**	**2031**	$ -	$ 3,296,008	$ 912,913	$ 4,208,921	$ 1,989,007	$ -	$ 2,672,635	$ -	$ 2,672,635	$ 1,263,006
8,095	**15**	**2032**	$ -	$ 3,628,996	$ -	$ 3,628,996	$ 1,625,547	$ -	$ 3,003,779	$ 693,296	$ 3,697,075	$ 1,656,042
8,312	**16**	**2033**	$ -	$ 3,789,908	$ -	$ 3,789,908	$ 1,609,123	$ -	$ 3,124,592	$ 4,998,661	$ 8,123,253	$ 3,448,979
8,530	**17**	**2034**	$ 15,389,664	$ 3,957,209	$ 142,509	$ 19,489,383	$ 7,843,435	$ 16,746,652	$ 3,249,951	$ 735,517	$ 20,732,120	$ 8,343,570
8,748	**18**	**2035**	$ -	$ 4,131,138	$ -	$ 4,131,138	$ 1,575,888	$ -	$ 3,380,018	$ 6,060,662	$ 9,440,680	$ 3,601,298
8,965	**19**	**2036**	$ -	$ 4,311,679	$ -	$ 4,311,679	$ 1,559,013	$ -	$ 3,514,811	$ -	$ 3,514,811	$ 1,270,882
9,183	**20**	**2037**	$ -	$ 4,714,100	$ 1,802,177	$ 6,516,277	$ 2,233,317	$ -	$ 3,912,086	$ 3,649,829	$ 7,561,915	$ 2,591,687
9,400	**21**	**2038**	$ -	$ 4,915,403	$ 1,122,768	$ 6,038,171	$ 1,961,570	$ -	$ 4,064,793	$ 5,794,818	$ 9,859,611	$ 3,203,009
9,618	**22**	**2039**	$ 17,840,839	$ 5,124,541	$ 165,207	$ 23,130,587	$ 7,122,501	$ 19,413,960	$ 4,223,142	$ 852,666	$ 24,489,768	$ 7,541,028
9,836	**23**	**2040**	$ -	$ 5,341,804	$ -	$ 5,341,804	$ 1,559,126	$ -	$ 4,387,333	$ 1,756,492	$ 6,143,825	$ 1,793,215
10,054	**24**	**2041**	$ -	$ 5,567,490	$ 175,268	$ 5,742,758	$ 1,588,772	$ -	$ 4,557,575	$ 6,332,154	$ 10,889,728	$ 3,012,715
10,272	**25**	**2042**	$ -	$ 6,052,653	$ 261,152	$ 6,313,805	$ 1,655,693	$ -	$ 5,033,456	$ 2,124,615	$ 7,158,070	$ 1,877,087
10,489	**26**	**2043**	$ -	$ 6,303,227	$ -	$ 6,303,227	$ 1,566,747	$ -	$ 5,225,204	$ 959,683	$ 6,184,887	$ 1,537,332
10,707	**27**	**2044**	$ 20,682,422	$ 6,563,388	$ 191,521	$ 27,437,331	$ 6,464,359	$ 22,506,100	$ 5,423,927	$ 7,907,789	$ 35,837,816	$ 8,443,551
10,925	**28**	**2045**	$ -	$ 6,833,486	$ 1,380,863	$ 8,214,349	$ 1,834,443	$ -	$ 5,629,870	$ 3,054,383	$ 8,684,254	$ 1,939,383
11,143	**29**	**2046**	$ -	$ 7,113,882	$ 203,184	$ 7,317,067	$ 1,548,873	$ -	$ 5,843,289	$ 7,340,702	$ 13,183,990	$ 2,790,780
11,361	**30**	**2047**	$ -	$ 7,697,620	$ 2,724,722	$ 10,422,342	$ 2,091,181	$ -	$ 6,412,570	$ 4,931,104	$ 11,343,674	$ 2,276,040
11,578	**31**	**2048**	$ -	$ 8,008,128	$ 215,558	$ 8,223,686	$ 1,564,013	$ -	$ 6,651,961	$ 3,337,607	$ 9,989,569	$ 1,899,855
11,796	**32**	**2049**	$ 23,976,596	$ 8,330,339	$ 222,025	$ 32,528,959	$ 5,863,966	$ 26,090,738	$ 6,899,945	$ 8,021,383	$ 41,012,067	$ 7,393,208
12,014	**33**	**2050**	$ -	$ 8,664,675	$ -	$ 8,664,675	$ 1,480,543	$ -	$ 7,156,821	$ 3,540,868	$ 10,697,689	$ 1,827,927
286,309		**Total:**	$ 167,793,136	$ 146,296,330	$ 11,435,516	$ 325,524,982	$ 158,018,747	$ 182,588,342	$ 120,613,946	$ 93,522,668	$ 396,724,956	$ 187,008,101

1.0 SCOPE OF SUPPLY

The following is the equipment supply for SORB 24R™ Chrome Removal Systems (CRS) for Northern California Utility at the well sites below.

Site	System	Well Flowrate	Vessels	Diameter
		[gpm]	[ea]	[ft]
Well No. 1	CRS-144D	1,400	2	12'
Well No. 2	CRS-096D	600	2	8'
Well No. 3	CRS-120Q	1,500	4	10'
Well No. 4	CRS-120D	1,000	2	10'
Well No. 5	CRS-120D	800	2	10'
Well No. 6	CRS-144D	1,200	2	12'
Well No. 7	CRS-144D	1,200	2	12'

Adsorber Vessels

75 psig vertical pressure vessels, with 5'-3" straight side wall and design features as follows:

- SA516-70 carbon steel plate.
- Designed and stamped to ASME Section VIII, Division 1 Code
- Interior coated with ANSI / NSF Std. 61 certified epoxy
- Exterior coated with two coats of self-priming epoxy
- Access ports: (1) 24" diameter on side wall, (1) 14" x 18" on top head
- 304 stainless steel inlet distributor/backwash collection pipe.
- 304 stainless steel effluent header with 304 stainless steel screened laterals.

Sorb 24R™ Media with support gravel

Adsorber Piping

- Cement-lined ductile iron process piping, painted same as vessel.
- Galvanized carbon steel relief and vent piping

Valves & Accessories

Butterfly valves will have lugged cast iron bodies and stainless steel discs. Manual butterfly valves have handwheel operators. Accessories will include expansion joints, pressure relief valve, quick connect adaptors and air release valves.

Instrumentation

- Influent magnetic flow meter for each adsorber
- Differential pressure switch for each adsorber

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mail info.dnwt@denora.com **web** www.denora.com

Blending Bypass Equipment

- Bypass Flow Magmeter
- Bypass Flow Control Valve (electric actuated butterfly valve)

pH Adjustment System

- H_2SO_4Storage Tank
- H_2SO_4 Storage Tank Level Element
- H_2SO_4 Metering Pump with pressure gage and calibration cylinder
- pH Probe
- Static Mixer

pH Readjustment System

- NaOH Storage Tank
- NaOH Storage Tank Level Element
- NaOH Metering Pump with pressure gage and calibration cylinder
- pH Probe
- Static Mixer

Local Control Panel

NEMA 4X control panel with Allen-Bradley® MicroLogix™ 1400 PLC and Allen-Bradley® PanelView Plus™ 600 HMI. Power to the panel is to be 120V, 1 ph, 60 hz. Panel controls the metering pumps and the bypass flow control valve only. Adsorbers are to be backwashed manually.

2.0 FIELD SERVICES

De Nora will furnish the services of a qualified field representative to instruct operation personnel and advise on equipment and media installation and start-up for nine (9) days in three trips per system except for Well No. 3 which would be ten (10) days in 3 trips.

Additional services can be purchased, if desired, at the rate of $1,500 per day (8 hr/day max.), including travel days, plus travel and living expenses to be billed at cost.

3.0 QUALIFICATIONS

The following items are not included in the De Nora ROM price:

- Freight to the job site
- ARRA compliance
- Receiving, unloading, storing and installation of De Nora supplied equipment
- Foundations for vessels, building/architectural work and engineering thereof.
- Anchor bolts for vessels or mechanical equipment
- Interconnecting piping or piping supports including flanges, bolts, nuts and gaskets,

and engineering thereof, outside the boundary of the piping on the adsorber vessels.
- Access ladders & platforms for adsorbers and other tanks
- Electrical starters, transformers, circuit breakers, VSDs, motor control center, and engineering thereof, and power supply
- Conduit and power wire
- Mounting brackets for transmitters
- Heat trace and insulation for freeze protection of pipe, instruments, and tanks
- Water supply/disposal for flushing of adsorber internals
- Performance testing; collection of samples and lab analysis
- Supply of chemicals
- Containment area & safety equipment (ie; eyewash, safety showers) for chemical systems
- Metering pumps must be housed at a minimum in a fiberglass enclosure, preferably in an air conditioned indoor environment
- Polyurethane finish paint coat for outdoor service
- Spare parts

4.0 PRODUCTION SCHEDULE

- Submittal of approval drawings 5 to 6 weeks after acceptance of PO
- Delivery of equipment 14 to 24 weeks after submittal approval.
- All delivery times are subject to confirmation at time of award.

5.0 OPTIONAL EQUIPMENT – NOT INCLUDED, BUT AVAILABLE

- Automatic operation
- AWWA butterfly valves
- Media fill and withdraw piping and valves. Withdraw piping to be polypropylene-lined steel. Valves to be 4" diameter 316 SS full port ball valves with lever handles. Hose connections to be quick disconnect adapters with dust covers with flush connection.
- Access platforms with handrail and ladders to top of adsorbers
- Auxiliary equipment for full bypass, and backwash handling
- Systems that operate in lag/lead series operation or are capable of both parallel or lag/lead operation.
- Piping materials of various materials and linings.

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 1**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

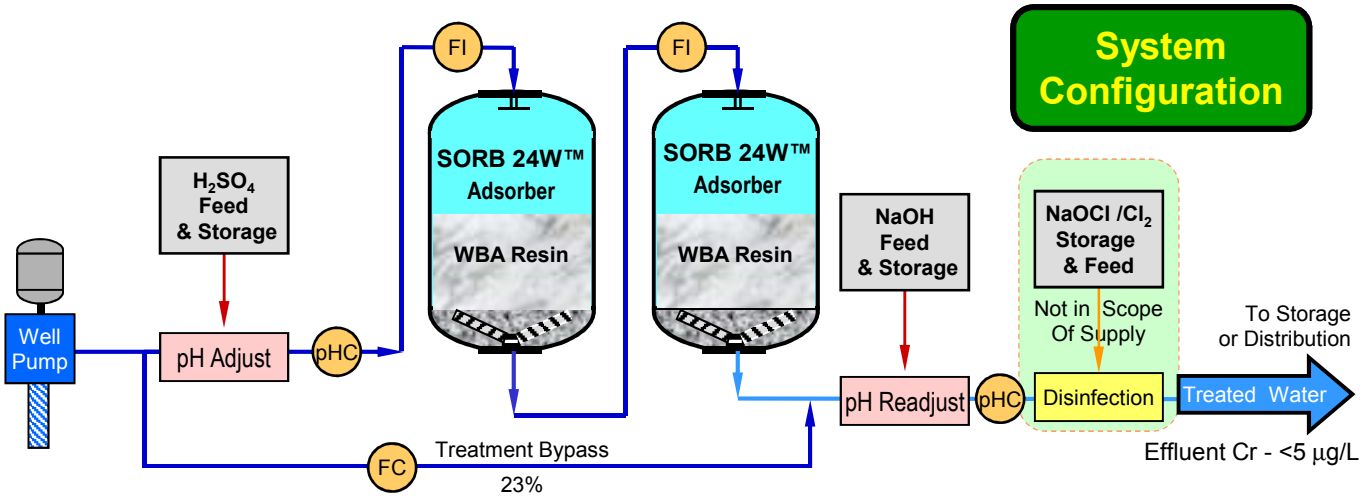
System Capacity & Operation

Well Capacity:	**1,400** gpm		
Treatment Flow:	**1,084** gpm	Treatment Bypass:	22.6% equal to 316 gpm
Avg Daily Capacity:	**2.02** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-144DM	Contact Time (EBCT) & Bed Depth:	6.4 Min; 4.1 ft
Adsorber No & Size:	Two 12 ft Diameter	Well Water Total Cr Analysis:	17.0 µg/L Cr
System Footprint:	28'L x14'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	9.6 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	352,300 BV's
Resin Quantity:	930 cubic ft	Service Cycle per Adsorber:	51.6 Months
	186 drums	Service Cycle per Train:	103.3 Months
		Volume Treated per Cycle:	2,451 M gals
SORB Backwash Rate:	230 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 5.9		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$188,600** per Yr or **$167 / Acre Ft**

Capital Costs: **$1,150,000**

Total Water Volume Treated: **2,451** million gal/cycle

Special Notes

DE NORA
our research - your future
De Nora Water Technologies
Inorganics Products

Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 2**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

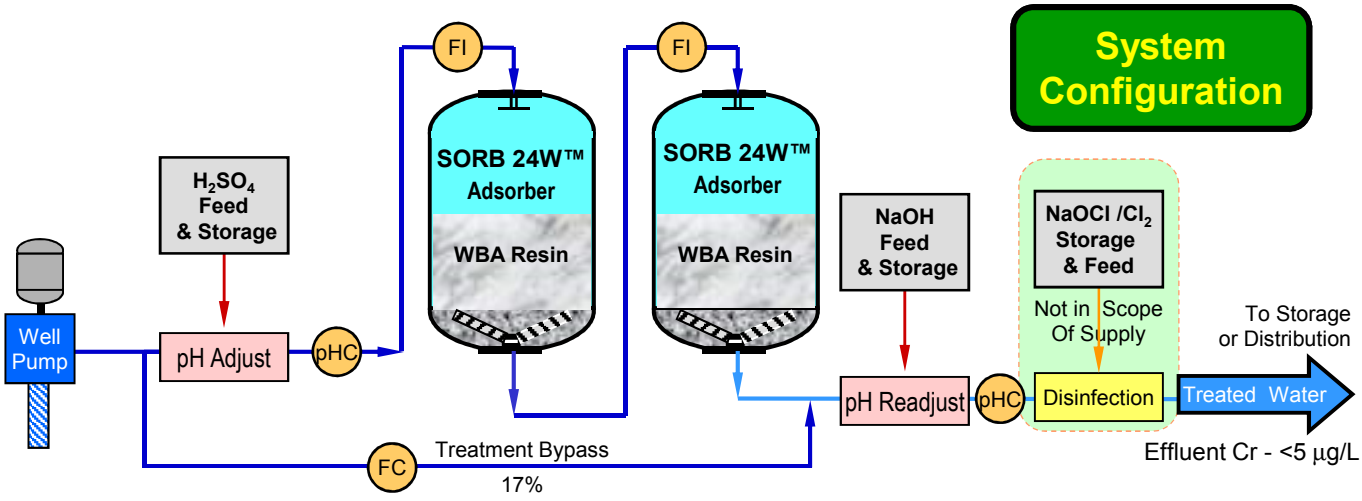
System Capacity & Operation

Well Capacity:	**600** gpm		
Treatment Flow:	**492** gpm	Treatment Bypass:	17.9% equal to 108 gpm
Avg Daily Capacity:	**0.86** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-096DM	Contact Time (EBCT) & Bed Depth:	6.2 Min; 4.1 ft
Adsorber No & Size:	Two 8 ft Diameter	Well Water Total Cr Analysis:	21.0 µg/L Cr
System Footprint:	20'L x 10'W x 12'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	9.8 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	280,000 BV's
Resin Quantity:	410 cubic ft	Service Cycle per Adsorber:	39.8 Months
	82 drums	Service Cycle per Train:	79.7 Months
		Volume Treated per Cycle:	859 M gals
SORB Backwash Rate:	100 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 5.9		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$93,600** per Yr or **$193 / Acre Ft**

Capital Costs: **$700,000**

Total Water Volume Treated: **859** million gal/cycle

Special Notes

Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

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SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 3**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

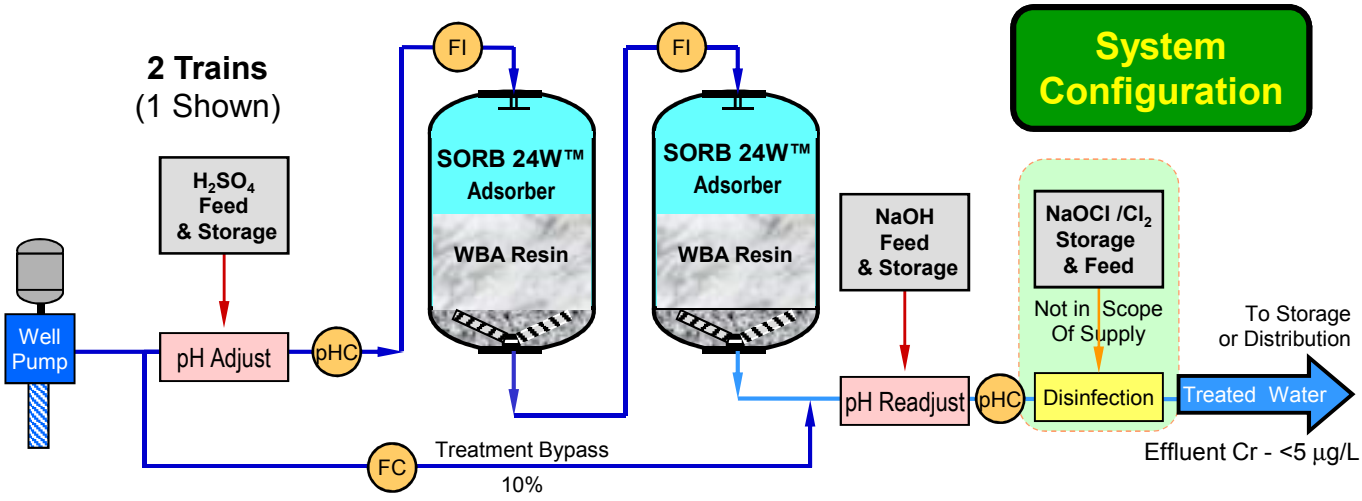
System Capacity & Operation

Well Capacity:	**1,500** gpm		
Treatment Flow:	**1,357** gpm	Treatment Bypass:	9.6% equal to 143 gpm
Avg Daily Capacity:	**2.16** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-120QM	Contact Time (EBCT) & Bed Depth:	7.2 Min; 4.1 ft
Adsorber No & Size:	Four 10 ft Diameter	Well Water Total Cr Analysis:	38.1 µg/L Cr
System Footprint:	24'L x 12'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	8.6 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	198,900 BV's
Resin Quantity:	1,300 cubic ft	Service Cycle per Adsorber:	32.6 Months
	260 drums	Service Cycle per Train:	65.1 Months
		Volume Treated per Cycle:	1,934 M gals
SORB Backwash Rate:	160 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 6.0		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$188,600** per Yr or **$167 / Acre Ft**

Capital Costs: **$1,550,000**

Special Notes

Total Water Volume Treated: **2,451** million gal/cycle

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Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 4**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

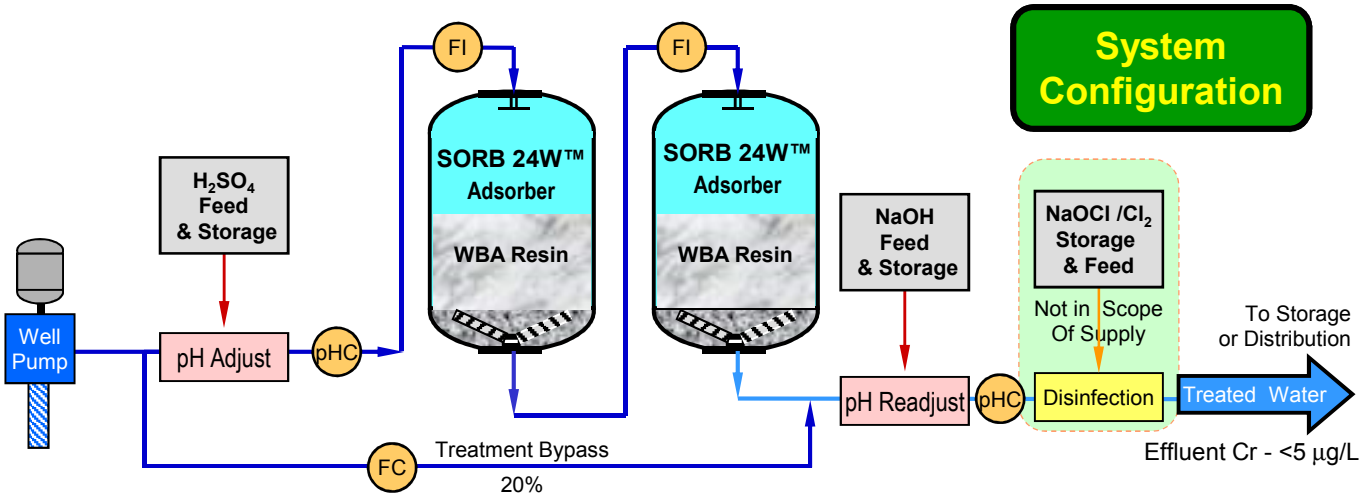
System Capacity & Operation

Well Capacity:	**1,000** gpm		
Treatment Flow:	**800** gpm	Treatment Bypass:	20.0% equal to 200 gpm
Avg Daily Capacity:	**1.44** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-120DM	Contact Time (EBCT) & Bed Depth:	6.1 Min; 4.1 ft
Adsorber No & Size:	Two 10 ft Diameter	Well Water Total Cr Analysis:	19.0 µg/L Cr
System Footprint:	24'L x 12'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	10.2 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	364,000 BV's
Resin Quantity:	650 cubic ft	Service Cycle per Adsorber:	50.5 Months
	130 drums	Service Cycle per Train:	101.0 Months
		Volume Treated per Cycle:	1,770 M gals
SORB Backwash Rate:	160 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 6.0		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$108,800** per Yr or **$135 / Acre Ft**

Capital Costs: **$900,000**

Total Water Volume Treated: **1,770** million gal/cycle

Special Notes

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Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 5**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

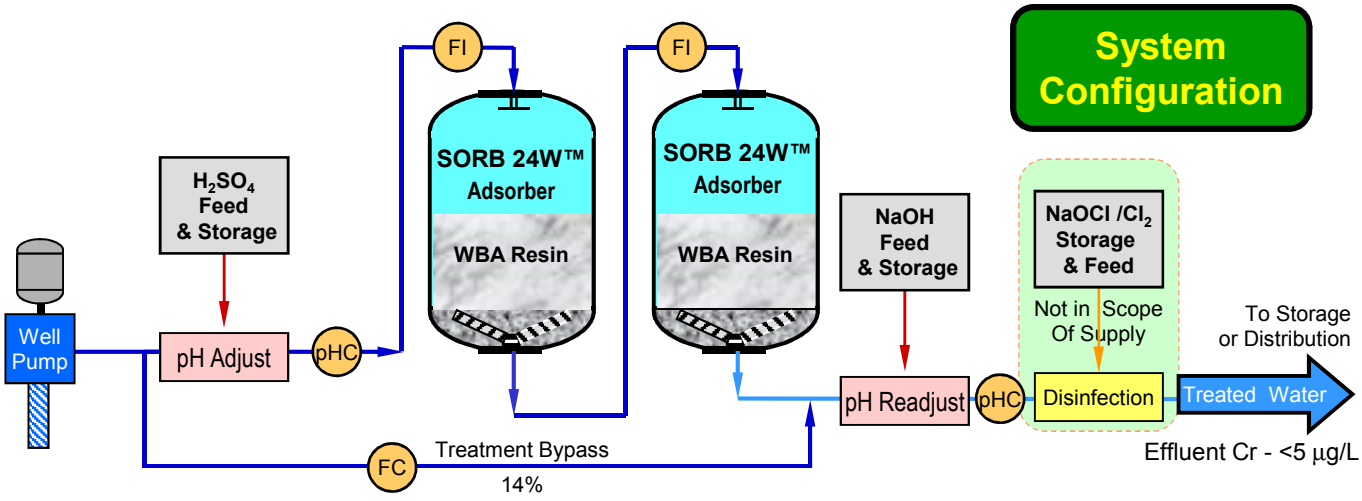
System Capacity & Operation

Well Capacity:	**800** gpm		
Treatment Flow:	**686** gpm	Treatment Bypass:	14.3% equal to 114 gpm
Avg Daily Capacity:	**1.15** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-120DM	Contact Time (EBCT) & Bed Depth:	7.1 Min; 4.1 ft
Adsorber No & Size:	Two 10 ft Diameter	Well Water Total Cr Analysis:	26.0 µg/L Cr
System Footprint:	24'L x 12'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	8.7 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	260,000 BV's
Resin Quantity:	650 cubic ft	Service Cycle per Adsorber:	42.1 Months
	130 drums	Service Cycle per Train:	84.2 Months
		Volume Treated per Cycle:	1,264 M gals
SORB Backwash Rate:	160 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 6.1		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$109,800** per Yr or **$170 / Acre Ft**

Capital Costs: **$900,000**

Special Notes

Total Water Volume Treated: **1,264** million gal/cycle

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Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 6**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

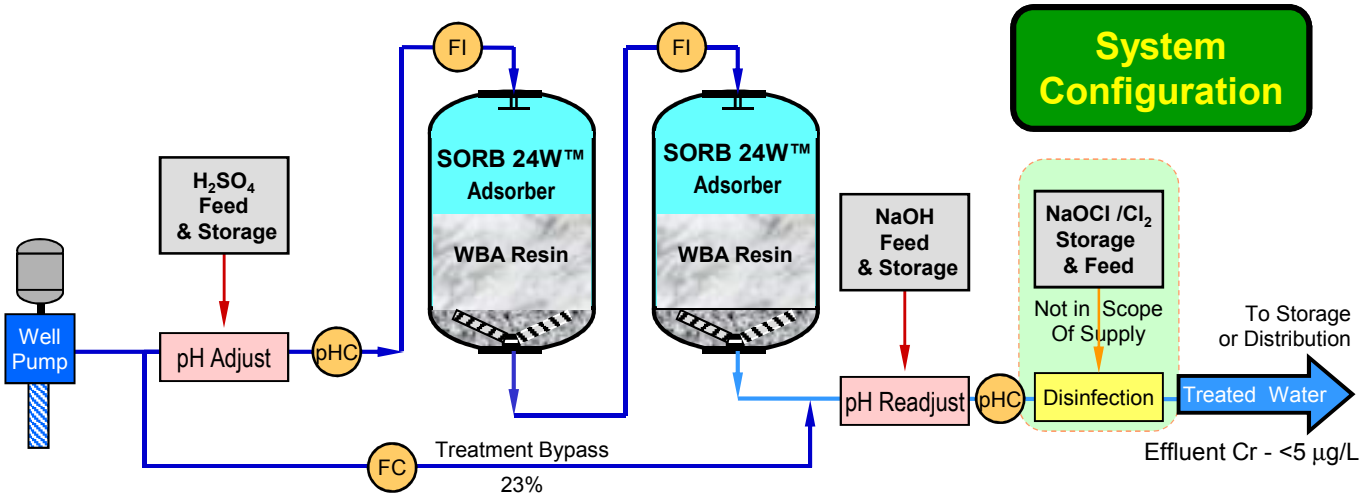
System Capacity & Operation

Well Capacity:	**1,200** gpm		
Treatment Flow:	**929** gpm	Treatment Bypass:	22.6% equal to 271 gpm
Avg Daily Capacity:	**1.73** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-144DM	Contact Time (EBCT) & Bed Depth:	7.5 Min; 4.1 ft
Adsorber No & Size:	Two 12 ft Diameter	Well Water Total Cr Analysis:	17.0 µg/L Cr
System Footprint:	28'L x14'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	8.2 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	411,000 BV's
Resin Quantity:	930 cubic ft	Service Cycle per Adsorber:	70.3 Months
	186 drums	Service Cycle per Train:	140.5 Months
		Volume Treated per Cycle:	2,859 M gals
SORB Backwash Rate:	230 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 6.1		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$120,000** per Yr or **$124 / Acre Ft**

Capital Costs: **$1,150,000**

Total Water Volume Treated: **2,859** million gal/cycle

Special Notes

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Issued: 30-Sep-16 RSD : A14 Proposal No. P-08527

SORB 24R™ Cr Removal System Sizing & Estimate

Project Information

Client: **No California Utility**
Site Name: **Well No. 7**
Contact: Alec Roberts
Engineer: RMC Water & Enviro't

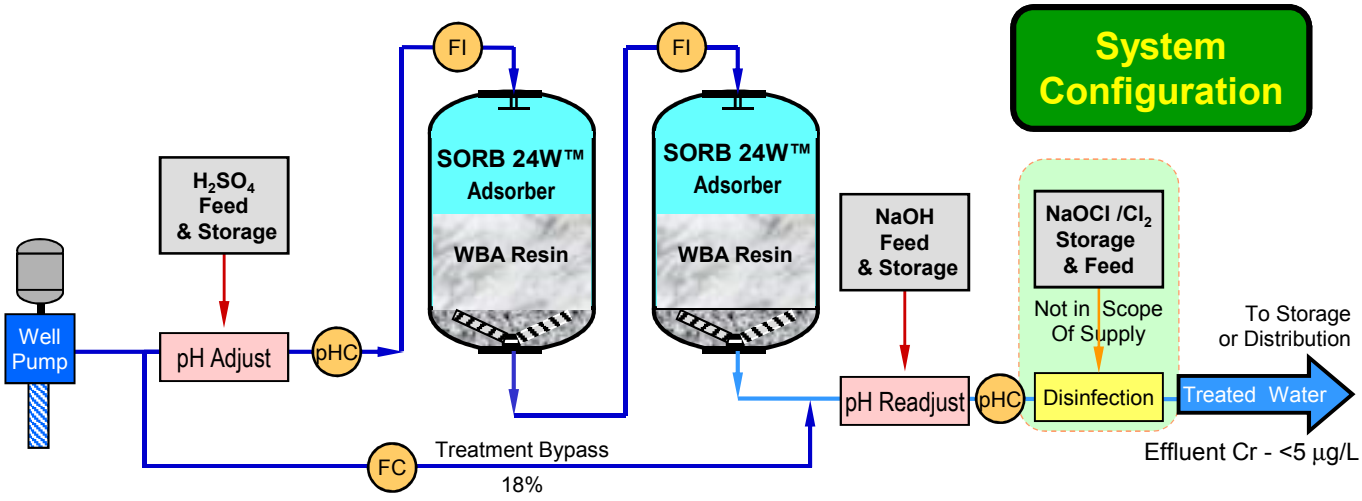
System Capacity & Operation

Well Capacity:	**1,200** gpm		
Treatment Flow:	**985** gpm	Treatment Bypass:	17.9% equal to 215 gpm
Avg Daily Capacity:	**1.73** MGD	Operating Factor:	50.0% r 12.0 Hrs/Day Avg

Design Parameters

SORB 24R™ Model No:	CRS-144DM	Contact Time (EBCT) & Bed Depth:	7.1 Min; 4.1 ft
Adsorber No & Size:	Two 12 ft Diameter	Well Water Total Cr Analysis:	21.0 µg/L Cr
System Footprint:	28'L x14'W x 14'H	Blended Water Total Cr Target:	5.0 µg/L Cr
Flow Configuration:	Series w/ Bypass	Loading Rate (Specific Velocity):	8.7 gpm/ft^2
Ion Exchange Resin:	STS Weak Base Anion	Water/Resin Treatment Ratio:	326,700 BV's
Resin Quantity:	930 cubic ft	Service Cycle per Adsorber:	52.7 Months
	186 drums	Service Cycle per Train:	105.4 Months
		Volume Treated per Cycle:	2,273 M gals
SORB Backwash Rate:	230 gpm	TDS Increase due to pH Adjust:	
	pH Adjust from 7.7 to 6.0		
Special Features:		Pres:	75 psig

System Configuration



Budgetary Capital & Operating Costs

Annual O&M Costs: **$151,600** per Yr or **$157 / Acre Ft**

Capital Costs: **$1,150,000**

Total Water Volume Treated: **2,273** million gal/cycle

Special Notes

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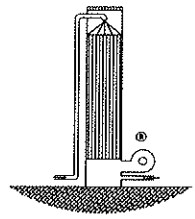


Delta Cooling Towers, Inc.
185 US Highway 206
Roxbury Twp., New Jersey 07836
Telephone 973-586-2201x201
Fax 973-586-2243
Email: sales@deltacooling.com
Web Address: www.deltacooling.com
Delta Cooling Towers

October 14, 2016

Alec Roberts
RMC Water and Environment
15510-C Rockfield Blvd., Suite 200
Irvine, CA 92618
P: 949-420-5313 | Fax: 949-420-5301

Subject: Northern CA, RO Degassifiers
Multiple Sites and Multiple Flows

Thank you for the opportunity to submit this Delta Induced Draft Aerator proposal for your consideration. We offer the following Delta Cooling Towers, Inc. standard design.

In response to the RFP, Delta recommends the following Vanguard® Air Strippers. These units will be able to remove free CO2 as found in the raw water.

Option #1 - One (1) Induced Draft Box Aerator (500gpm)
(Well #2 Only)

The aerator is a 5'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include One (1) inline 0.5hp TEFC 230/460/3/60 blower/motor assembly designed for 2,000cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- A 6" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and an 8" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.

- ***NOTE: All taxes both sales and use are specifically excluded.***

The total net price for the Aerator System is **$41,500.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

Option #2 - One (1) Induced Draft Box Aerator (700gpm)
(Well #5 Only)

The aerator is a 7'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include One (1) inline 0.75hp TEFC 230/460/3/60 blower/motor assembly designed for 2,810cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- A 6" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and an 8" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.
- ***NOTE: All taxes both sales and use are specifically excluded.***

The total net price for the Aerator System is **$53,650.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

Option #3 - One (1) Induced Draft Box Aerator (800gpm to 900gpm)
(Well #4 & Well #6 Only)

The aerator is a 8'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include One (1) inline 1.0hp TEFC 230/460/3/60 blower/motor assembly designed for 3,610cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- An 8" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and a 10" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.
- ***NOTE: All taxes both sales and use are specifically excluded.***

The total net price for the Aerator System is **$63,500.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

Option #4 - One (1) Induced Draft Box Aerator (1,000gpm)
(Well #1 & Well #7 Only)

The aerator is a 9'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include One (1) inline 1.5hp TEFC 230/460/3/60 blower/motor assembly designed for 4,010cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- A 10" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and a 12" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.

- ***NOTE: All taxes both sales and use are specifically excluded.***

The total net price for the Aerator System is **$76,000.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

Option #5 - One (1) Induced Draft Box Aerator (1,400gpm)
(Well #3 Only)

The aerator is a 10'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include Two (2) inline 1.0hp TEFC 230/460/3/60 blower/motor assembly designed for 2,810cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- A 10" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and a 12" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.
- ***NOTE: All taxes both sales and use are specifically excluded.***

The total net price for the Aerator System is **$85,000.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

Option #6 - Three (3) Induced Draft Box Aerator (6,600gpm Total)
(Centralized Treatment Alternative Only)

Each aerator is a 12'-0" square fiberglass box with 10'-0" of Delta Cooling Towers, Inc. PVC angle slat internals, factory installed prior to shipment to the jobsite. The tower will be free-standing when anchored to a suitable concrete foundation or stand. The system will be designed for induced draft operation.

The other items included in Delta Cooling Towers, Inc.'s scope of supply for this project are:

- Each tower will include Two (2) inline 2.0hp TEFC 230/460/3/60 blower/motor assembly designed for 4,415cfm @ 0.75" W.C., with weather cover.
- Each aerator will be supplied with inlet air bird and insect screen intake windows.
- The aerator tower will be provided with the necessary flanges, nozzles, connections, lifting lugs, inspection doors, and manways.
- The stripper will also be supplied with the required internals; stainless steel slat support grids, PVC mist eliminator, and PVC inlet distribution system.
- A 12" FRP influent pipe terminating at a flange approximately 6" outside the aerator wall, and a 14" effluent flanged FRP outlet nozzle connection complete with vortex breaker. See attached catalog drawing for scope of supply.
- Design of the concrete support pad is specifically excluded (load values will be supplied) with supply and installation of anchor bolts by others (Typically (4) @ 7/8"Dia.).
- All the necessary drawings, submittals for approval and O&M manuals.
- ***NOTE: All taxes both sales and use are specifically excluded.***

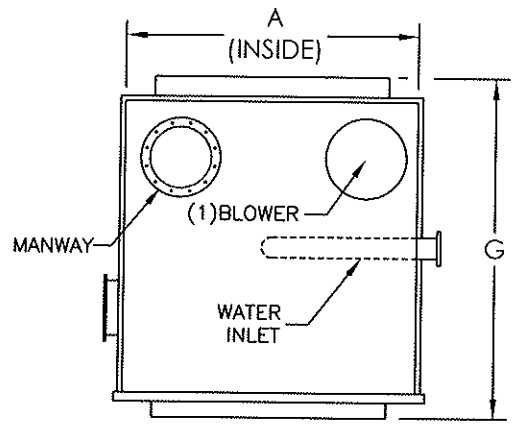
The total net price for the Aerator System is **$100,000.00 per tower**, FOB Philippi, W. VA., **freight to jobsite pre-paid and add**. Shipment can be made approximately 8 ***weeks*** after receipt of "Approved" submittals and authorization to proceed with fabrication. Please allow ***1 week*** for preparation of submittals.

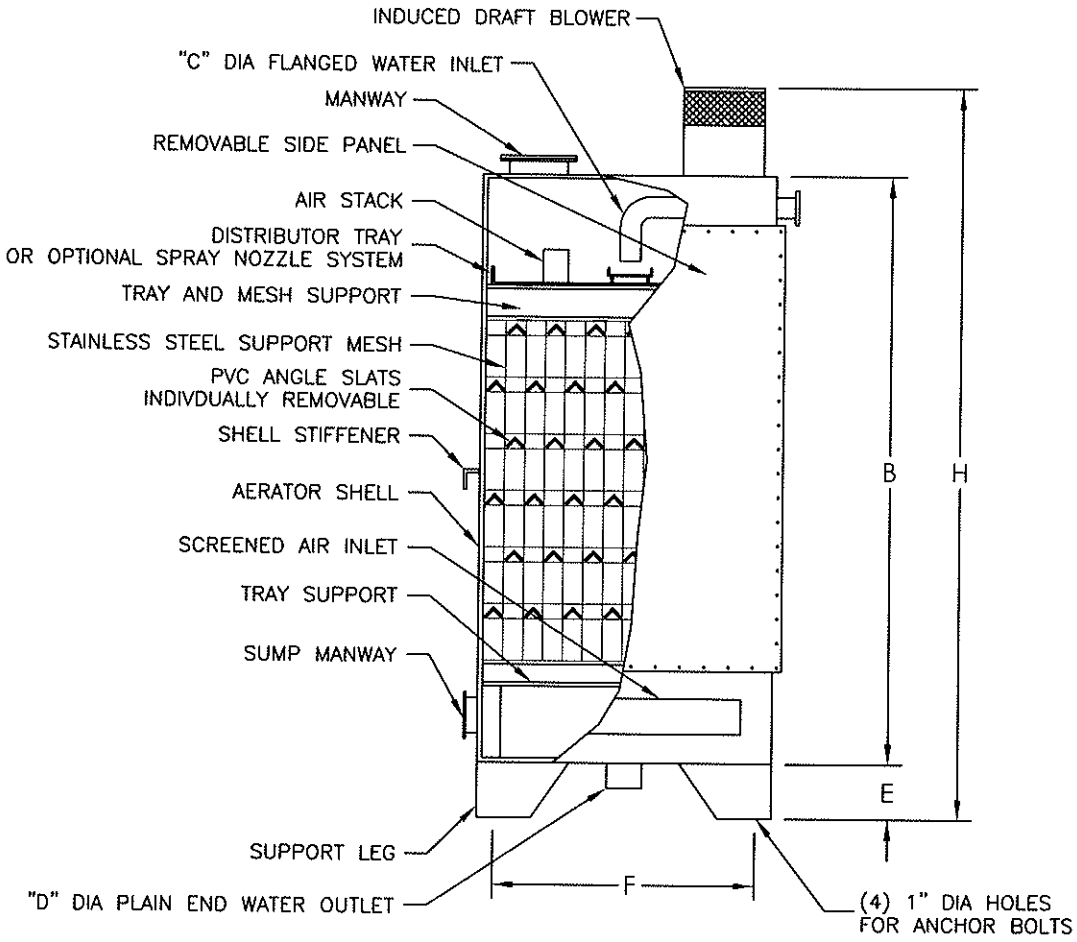
Thank you for your interest in Delta and its products, and for the opportunity to be of service. Please feel free to contact the undersigned with any questions comments or if I can be of any additional assistance.

Sincerely,

Joseph B. Homza, Jr.

Joseph B. Homza, Jr.
Vice President – Municipal Products Division





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
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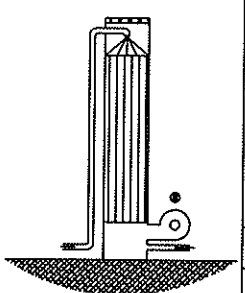


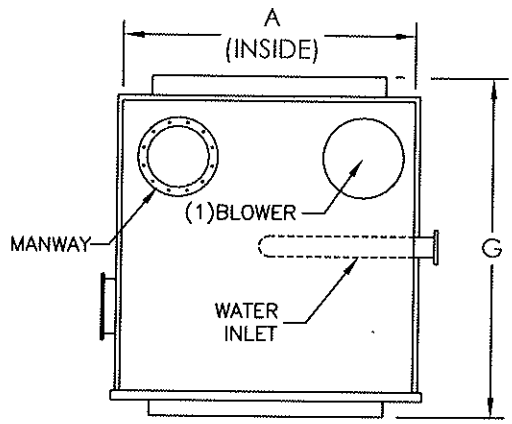
VANGUARD®

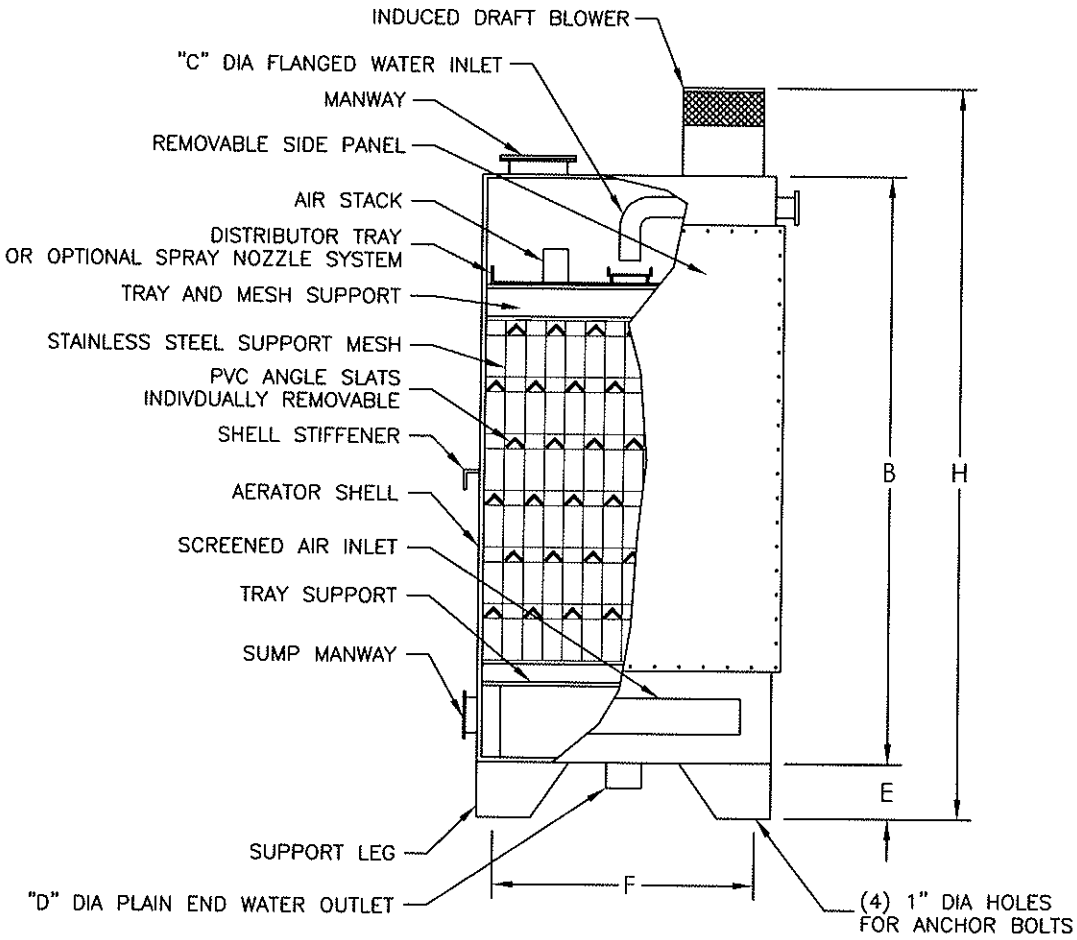
DELTA COOLING TOWERS, INC.

185 US HIGHWAY 206, ROXBURY TWP., NJ 07836
PH (973) 586-2201 FAX (973) 586-2243

TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO.
DATE 10/17/16	IDA-STD-A-1 500gpm UNIT





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
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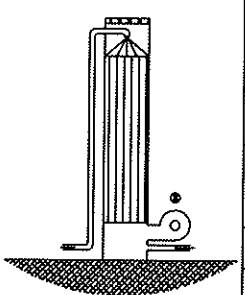


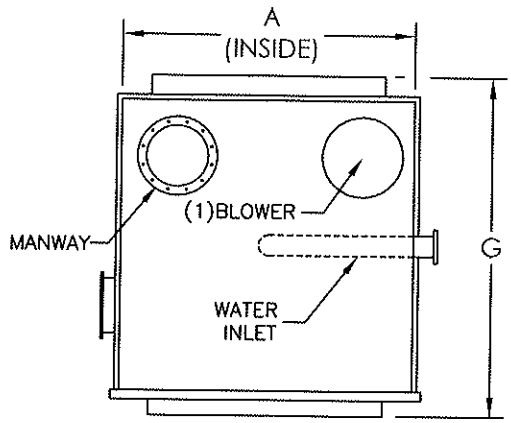
VANGUARD®

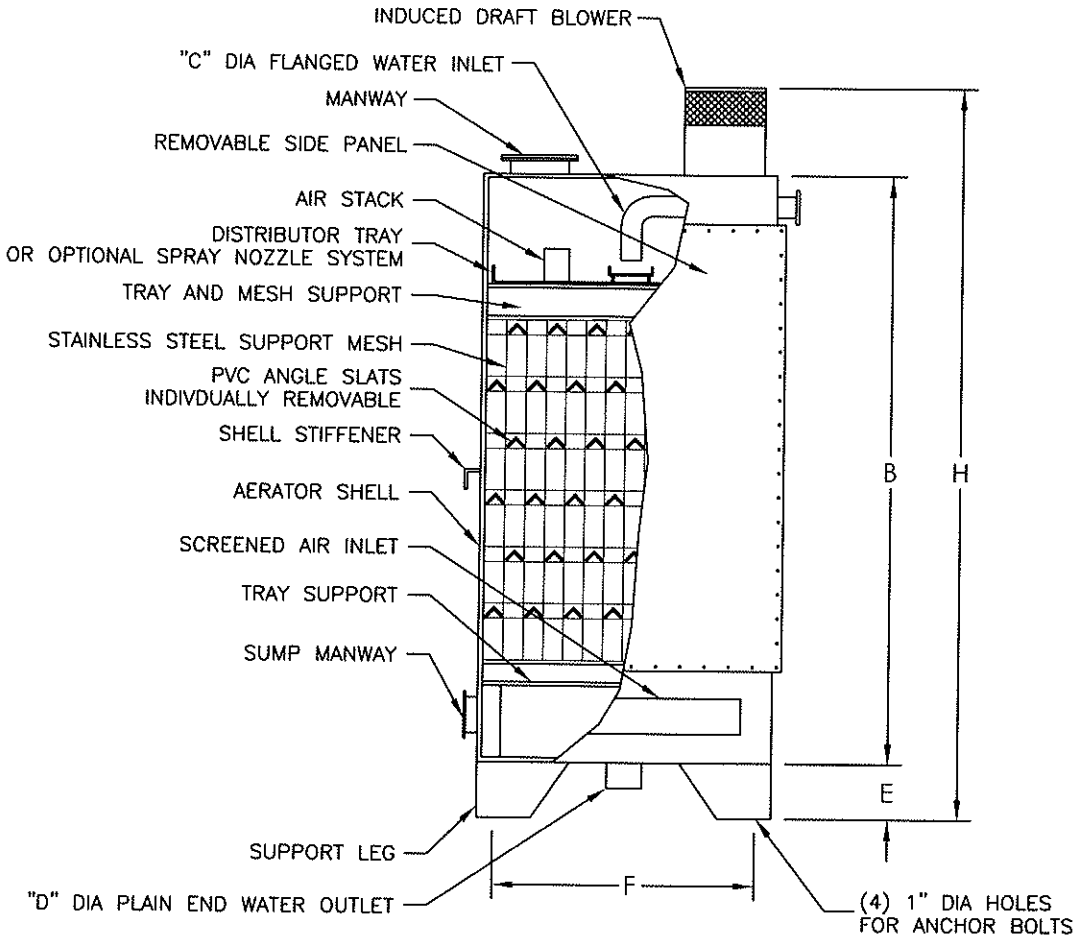
DELTA COOLING TOWERS, INC.

185 US HIGHWAY 206, ROXBURY TWP., NJ 07836
PH (973) 586-2201 FAX (973) 586-2243

TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO. IDA-STD-A-1 700gpm UNIT
DATE 10/17/16	





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
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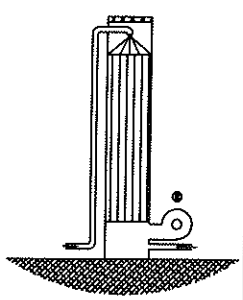

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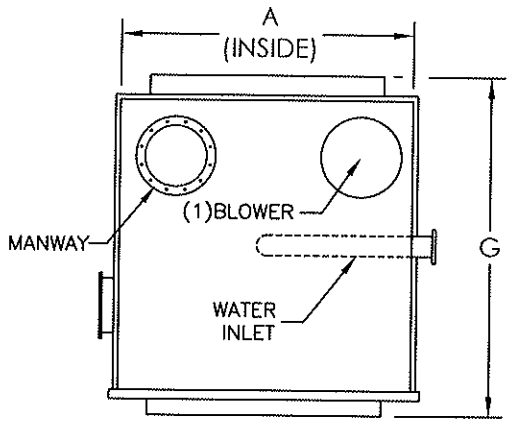
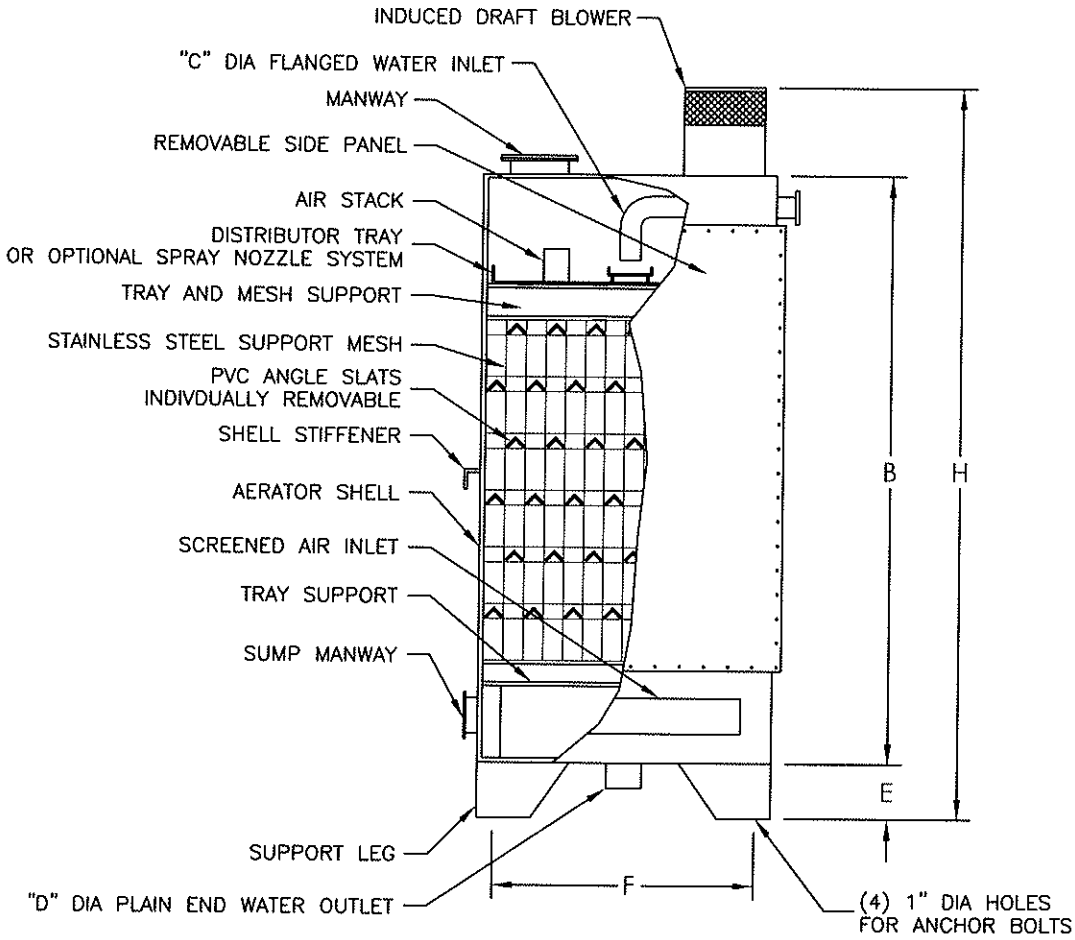
PH (973) 586-2201 FAX (973) 586-2243

TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO. IDA-STD-A-1 800-900gpm UNIT
DATE 10/17/16	





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
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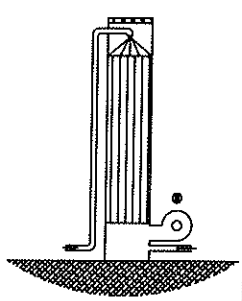

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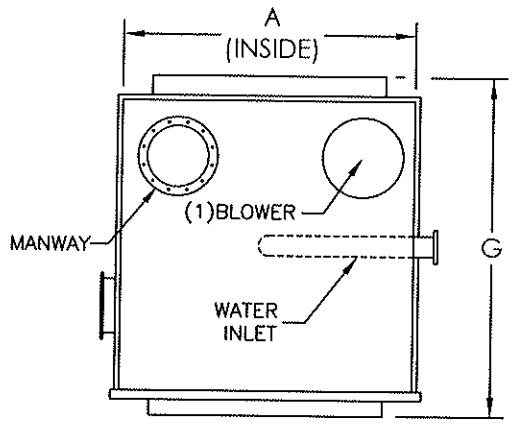
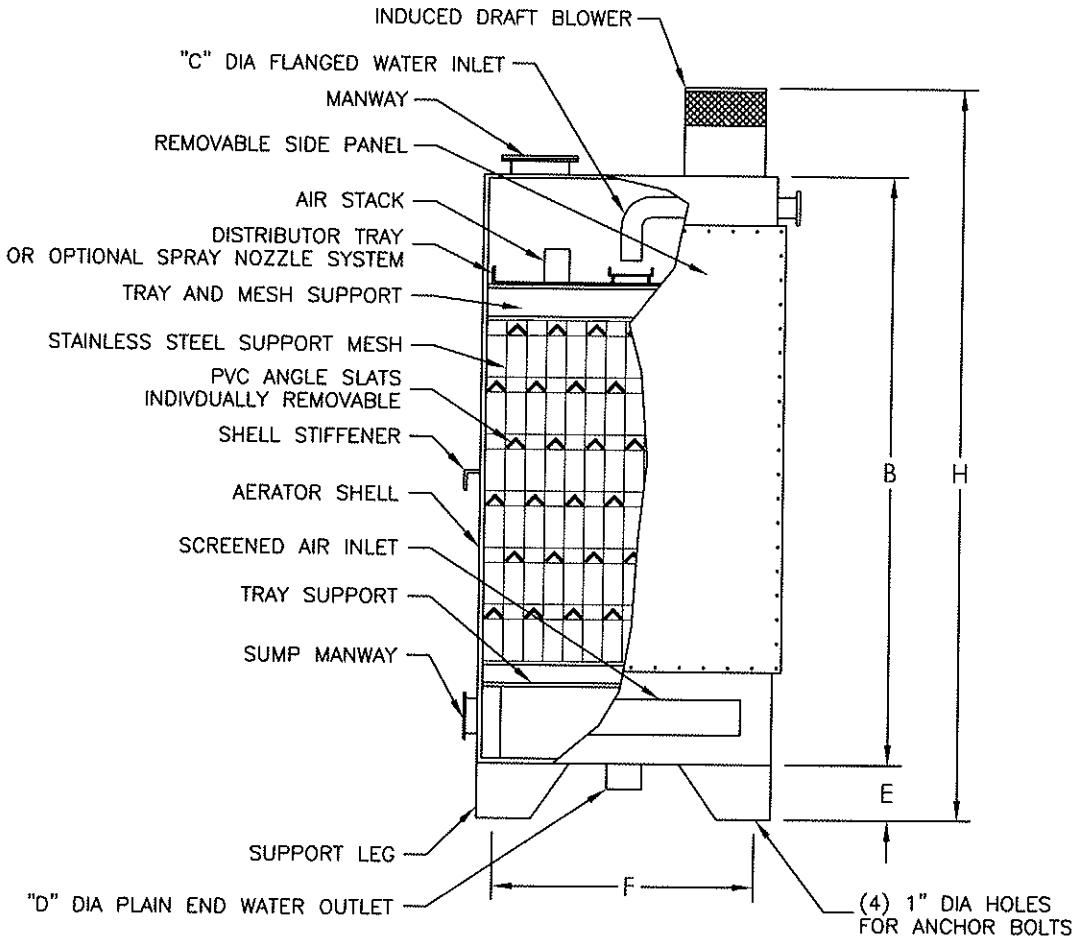
TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO.
DATE 10/17/16	IDA-STD-A-1 1,000gpm UNIT





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
10'-0"	12'-0"	10"	12"	N/A	1'-0"	9'-0"	11'-6"	15'-0"	–	–	–	–	–

DELTA COOLING TOWERS, INC.

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PH (973) 586-2201 FAX (973) 586-2243

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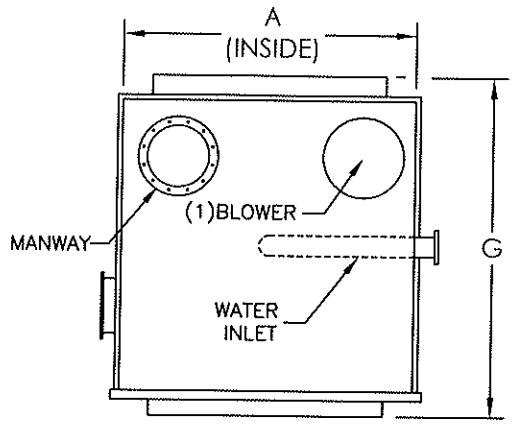
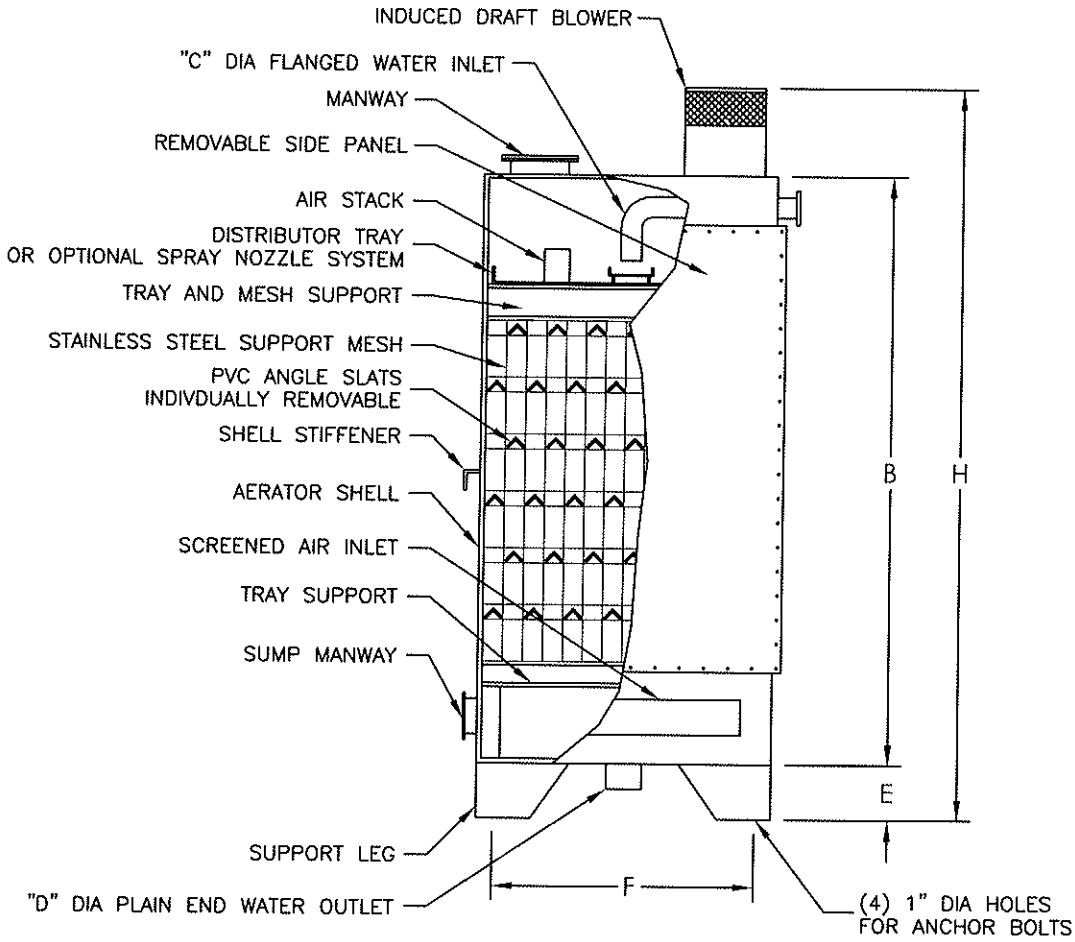
TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO. IDA-STD-A-1 1,400gpm UNIT
DATE 10/17/16	





A	B	C	D	PB	E	F	G	H	J	K	L	M	N
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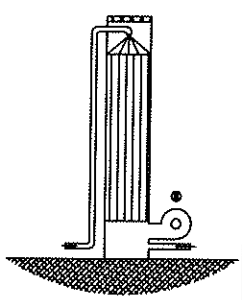

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PH (973) 586-2201 FAX (973) 586-2243

TITLE VANGUARD® AERATION TOWERS
INDUCED DRAFT WITH STANDARD SIDE INLET

PROSPECT NAME: RMC Decarbonators	DWN BY J.B. Homza
PROSPECT NUMBER: B16-032	APPVD BY J.C. Flaherty
SCALE NTS	DWG NO. IDA-STD-A-1 (3) at 2,200gpm UNIT
DATE 10/17/16	

DELTA
Cooling Towers, Inc.

CONDITIONS OF SALE AND WARRANTY

Terms and Conditions

1. **Sale Not a Consumer Transaction:** Buyer agrees that the purchase of Delta's Products (hereinafter "Product") is not for consumer, household or family purposes.
2. **Agreement of Sale: Acceptance:** Any acceptance contained herein is expressly made conditional on Buyer's assent to any terms contained herin that are additional to or different from those proposed by Buyer in its purchase order and hence any terms and provisions of Buyer's purchase order which are inconsistent with the terms and conditions hereof shall not be binding on the Seller. Unless Buyer shall notify Seller in writing to the contrary as soon as practicable after receipt hereof, acceptance of the terms and conditions hereof by Buyer shall be deemed made and, in the absence of such notification the sale and shipment by the Seller of the goods covered hereby shall be conclusively deemed to be subject to the terms and conditions hereof.
3. **Entire Contract:** This contract constitutes the final and entire agreement between Seller and Buyer and any prior or contemporaneous understandings or agreements, oral or written are merged herein. The sales and technical representatives of the Seller are not authorized to make warranties about the product. Sellers representatives' oral statements do not constitute warranties, shall not be relied upon by the Buyer, and are not part of the contract for sale. Any product-literature and operating instructions, and statements contained therein, do not constitute warranties, shall not be relied upon by the Buyer and are not part of the contract for sale. The entire contract is embodied in this writing and no other warranties are given beyond those set forth in this contract. This writing constitutes the final written expression of the parties agreement, and it is a complete an exclusive statement of the terms of the agreement.
4. **Prices:** Except where expressly agreed, all prices are subject to change without notice. If there is a delay in approval of drawings related to this contract beyond 30 days, an escalation in selling price may occur due to a rise in labor and/or material prices.
5. **Taxes:** The price of goods does not include sales, use, excise, ad valorem, property or other taxes now or hereinafter imposed, directly or indirectly by any governmental authority or agency with respect to the manufacture, production, sale, delivery, consumption or use of goods covered by this contract. Buyer shall pay such taxes directly or reimburse Seller for any such taxes which it may be required to pay.
6. **Payment:** The specific terms of payment are as specified in writing by Seller. If the Buyer shall fail to make any payments in accordance with the terms and provisions hereof, the Seller, in addition to its other rights and remedies, but not in limitation thereof, may, at its option, defer shipments or deliveries hereunder, or under any other contract with the Buyer, except upon receipt of satisfactory security or of cash before shipment.
7. **Shipment; Risk of Loss Title: The goods shall be shipped FOB Seller's shipping points.** Risk of loss shall pass to Buyer upon delivery to the carrier. Title shall pass to Buyer on delivery to the carrier.
8. **Delivery; Delays in Deliveries:** The date of delivery provided herein is an approximation based on Seller's best judgement. Seller shall be excused for delay in delivery, may suspend performance and shall under no circumstances be responsible for failure to fill any orders when due to acts of God or of the public enemy; fires; floods; riots; strikes, freight embargos or transportation delays; shortage of labor; inability to secure fuel; material supplies, or power at curent prices or on account of shortages thereof; any existing or future laws or acts of the Federal or of any State Government (including specifically, but not exlusively, any orders, rules or regulations issued by any official or agency of any such government).
9. **LIMITED WARRANTY:** Seller warrants that the cylindrical, seamless molded polyethylene shell of the Product shall be free from defects in materials and workmanship and will not peel, chip, rust or need painting for a period of fifteen (15) years from the date of shipment. Since the Product once in operation is under the sole control of the User, this warranty is further subject to and shall be applicable only if all of the following conditions are met:
   a. The Product has been properly erected in accordance with the Seller's instructions and in accordance with good installation practices;
   b. Seller's instructions and recommendations as to operation and maintenance have been followed, including those contained in the manual furnished with the Product;
   c. The Product has been used under normal operating conditions;
   d. The Product has not been affected by misuse, neglect, accident or abrasion;
   e. The User has not attempted or performed corrective work on the Product without Seller's prior written consent; and
   f. The Seller shall have received notice of any defect no later than 10 days after User first has knowledge of same.

   Except where expressly noted otherwise, Seller warrants all Product componets, other than moving parts, against defects in workmanship and material for a period of one (1) year from the date of shipment, provided the equipment has been properly manintained and operated under normal conditions. Motors and blowers carry a normal manufacturer's one (1) year warranty against defects in workmanship and materials beginning from the date of shipment and subject to the same condtions of proper use and operation as other components of the Product. Bearings, pulleys, belts or other moving parts and components are sold without any warranty.
10. **DISCLAIMER OF ALL OTHER WARRANTIES AND GUARANTEES: The aforesaid warranty is the sole and only warranty or guarantee relating to the product provided under this Agreement, and is in substitution for, and in lieu of, any and all other warranties, written or oral, expressed, implied or statutory including any warranty of merchantability or of fitness for a particular purpose.**
11. **CORRECTION OF DEFECTS AS SOLE REMEDY:** If the Buyer/User gives the Seller written notice of defects in the product within any period of warranty described herein and the Seller's inspection confirms the existence of such defect, the Seller, at its option, shall correct the defect or defects either by repair, providing repair tools and instrutions, or replacement, FOB Seller's shipping point, or refund the purchase price of the product. The remedies provided Buyer/User herein for breach of Seller's warranty shall be exclusive.
    No expense, liability or responsibility will be assumed by the Seller for repairs made by other than Seller's agent without written authority from the Seller.
    Remedial action, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of Seller to the Buyer / User, and Buyer/User's sole remedy hereunder, whether based on contract, tort or otherwise.
    The sole purpose of stipulated exlusive remedy shall be to provide the User with free repair and replacement of defective parts in the manner provided herein. This exclusive remedy shall not be deeded to have failed of its essential purpose so long as the Seller is willing and able to repair or replace defective parts in the prescribed manner.
    An action for breach of this limited warranty or any other action otherwise arising out of this contract must be commenced within one (1) year from the date the right, claim, demand or cause of action shall first occur, or be barred forever.
12. **STATEMENT OF BUYER/USER'S RESPONSIBILITIES:** It is the sole responsibility of the Buyer/User, and not in any manner the responsibility of the Seller, to test, control and properly dispose of all discharges, both gaseous and liquid, from the product to assure:
    a. Compliance with all federal, state and municipal (or any political subdivision thereof) statutes, laws, codes, ordinances, rules and regulations concerning the environment, including but not limited to: The Clean Air Act, 42 U.S.C. S7401 *et seq.*; The Clean Water Act, 33 U.S.C. S1251 *et seq.*; The Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. S9601 *et seq.*; The Toxic Substance Control Act, 15 U.S.C. S2601 *et seq.*; The Resource Conservation and Recovery Act, 42 U.S.C. S6901 *et seq.*; The Safe Drinking Water Act, 21 U.S.C. S349 *et seq.*; The National Environmental Policy Act, 42 U.S.C. S4321 *et seq.*; Occupational Safety and Health Act, 29 U.S.C. S651 *et seq.*; together with any amendments thereto and regulations promulgated thereunder;
    b. Adequate protection for the health and safety of people, property, wildlife and environment; and
    c. Adequate protection for all persons, including employees, coming in contact with the Product and its discharges for all purposes including, without limitation, installation, maintenance, use and repair of the Product.

    It is also the sole responsibility of the Buyer/User to:
    d. Maintain the Product in accordance with the "Installation, Operating and Maintenance Instructions";
    e. Comply with the maintenance checklist contained in the "Installation, Operating and Maintenance Instructions"; and
    f. Periodically monitor and test the Product to verify proper functioning, and to insure the Product performs properly.

    It is further the sole responsibility of the Buyer/User to comply with all laws, codes, and regulations relating to the Product and its use and Seller makes no warranty or representation with respect thereto.
    Buyer/User assumes the responsibility for providing and installing all devices required to protect the health and safety of people, property, wildlife and the environment.
    Buyer/User acknowledges having read the "Installation, Operating and Maintenance Instructions", including all warnings contained therein, and is aware of the precautions recommended for protection to the health and safety of people, property, wildlife, and the environment, including employees coming in contact with the Product discharges.
    Buyer/User assumes full responsibility to assure proper use of the Product, including the determination and control of what chemicals, pollutants and toxic substances are introduced into the product, and the determination and control of all discharges from the Product.
13. **DISCLAIMER OF TORT, CONTRACT, STATUTORY AND ALL OTHER LIABILITY:** The Seller hereby disclaims all tort, contract or statutory liability to the Buyer/User, and any other basis of liability to Buyer/User regarding claims for injury or damage to people, property, wildlife, or the environment, including, without limitation, claims of negligence, strict product's liability, breach of warranty (except the limited warranties as provided in paragraph 9 entitled: "Limited Warranty"), breach of contract or violation of stature, law, ordinance, code, rule or

Form at-1170, Effective 4/98
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regulation. Seller also disclaims any liability to the Buyer/User in contribution or indemnification for the Buyer/User's liability or alleged liability to any third person or entity for injury or damage to people, property, wildlife or the environment. Without limiting the generality of the foregoing, Seller disclaims liability for all claims for compensatory, consequential, incidental or other damages and for damages for personal injury and property damage, loss of use, revenue or profit, injury to good will, inability to fulfill contracts to third parties, other economic loss, response costs and other environmental clean-up costs or other damages arising out of the actual, alleged or threatened discharge, dispersal, release or escape of pollutants, contaminants, hazardous waste, or liquid or gaseous materials discharged from or through the Product and any loss, cost or expense arising out of any governmental or other direction or request to test for, monitor, clean-up, remove, contain, treat, detoxify or neutralize the foregoing.

Seller also disclaims liability for all claims for damages arising from the actual or alleged violation of any federal, state, municipal (or political subdivision thereof) statute, law, ordinance, code, rule or regulation relating to the environment, including but not limited to: The Clean Air Act, 42 U.S.C. S7401 *et seq.*; The Clean Water Act, 33 U.S.C. S1251 *et seq.*; The Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. S9601 *et seq.*; The Toxic Substances Control Act, 15 U.S.C. S2601 *et seq.*; The Resource Conservation and Recovery Act, 42 U.S.C. S6901 *et seq.*; The Safe Drinking Water Act, 21 U.S.C. S349 *et seq.*; The National Environment Policy Act, 42 U.S.C. S4321 *et seq.*; Occupational Safety and Health Act, 29 U.S.C. S651 *et seq.*; together with any amendments thereto and regulations promulgated thereunder.

Seller further disclaims any liability, direct or indirect, resulting from the Buyer/User's failure to fulfill the responsibilities enumerated in the proceeding paragraph entitled "Statement of Buyer/User's Responsibility" including without limitation:

a. Buyer/User's failure to comply with statutes, laws, codes, rules and regulations relating to the Product and the environment; and
b. Buyer/User's failure to provide and install all devices required for the protection of the safety and health of people, property, wildlife and the environment and all persons, including employees of the User coming in contact with the Product and its discharges; and
c. Buyer/User's failure to adhere to the "Installation, Operating and Maintenance Instructions" and the product literature, including all warning contained therein;
d. Buyer/User's failure to test and monitor the functioning of the Product; and
e. Buyer/User's failure to determine and control the safety and cleanliness of discharged effluents, both gaseous and liquid, from the Product.

14. **EXCULPATORY AND INDEMNIFICATION AGREEMENT:** Buyer/User hereby agrees that the Seller will not be liable to the Buyer/User for the matters reffered in paragraph 13 entitled "Disclaimer of Tort, Contract, Statutory and All Other Liability." This exculpatory agreement applies even if the defect and/or loss, damage or injury to persons, property, wildlife and the environment resulted solely or in part from the Seller's actualor alleged negligence, breach of warranty, violation an statute, law, ordinance, rule or regulatio, or actions resulting in strict liability.

The Buyer/User hereby agrees to defend, hold harmless and indemnify the Seller and Seller's agents from and against all claims, suits, actions, and liabilities for injury or damage to people, property, wildlife, or the environment, including, without limitation, claims of negligence, strict products liability, breach of warranty (except the limited warranties provided in paragraph 9 entitled "Limited Warranty"), breach of contract or violation of statute, law, ordinance, code, rule or regulation.

The Buyer/User hereby agrees to defend, hold harmless and indemnify the Seller and Seller's agents from and against all claims, suits, and actions including claims for contribution or imdemnification for another's liability or alleged liability to any third person or entity for injury or damage to people, property, wildlife or the environment.

Without limiting the generality of the foregoing, the Buyer/User hereby agrees to defend, hold harmless and idemnify the Seller and Seller's agents from and against all claims, suits, actions, and liabilities for compensatory, consequential, incidental or other damages and for damages for personal injury and property damage, loss of use, revenue or profit, injury to good will, inability to fulfill contracts to third parties, other economics loss, reponse costs and other environmental clean-up cost or other damages arising out of the actual, alleged or threatened discharge, dispersal, release or escape of pollutants, contaminants, hazardous waste, or liquid or gaseous materials discharged from or through the Product and any loss, cost or expense arising out of any governmental or other direction or request to test for, monitor, clean-up, remove, contain, treat, detoxify or neutralize the foregoing.

The Buyer/User hereby agrees to defend, hold harmless and indemnify the Seller and Seller's agents from and against all claims, suits, actions, and liabilities for damages arising from the actual or alleged violation of any federal, state, municipal (or political subdivision thereof) statute, law, ordinance, code, rule or regulation relating to the environment, including but not limited to: The Clean Air Act, 42 U.S.C. S7401 *et seq.*; The Clean Water Act, 33 U.S.C. S1251 *et seq.*; The Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. S9601 *et seq.*; The Toxic Substances Control Act, 15 U.S.C. S2601 *et seq.*; The Resource Conservation and Recovery Act, 42 U.S.C. S6901 *et seq.*; The Safe Drinking Water Act, 21 U.S.C. S349 *et seq.*; The National Environment Policy Act, 42 U.S.C. S4321 *et seq.*; Occupational Safety and Health Act, 29 U.S.C. S651 *et seq.*; together with any amendments thereto and regulations promulgated thereunder.

The Buyer/User hereby agrees to defend, hold harmless and indemnify the Seller and Seller's agents from and against all claims, suits, actions, and liabilities, direct or indirect, resulting from the Buyer/User's failure to fulfill the responsibilities enumerated above in number 12 entitled "Statement of Buyer/User's Responsibilities" as if the Buyer were the User as referred to therein, including without limination:

a. Buyer/User's failure to comply with statutes, laws, codes, rules and regulations relating to the Product and the environment; and
b. Buyer/User's failure to provide and install all devices required for the protection of the safety and health of people, property, wildlife and the environment and all persons, including employeesof the User coming in contact with the Product and its discharges; and
c. Buyer/User's failure to adhere to the "Installation, Operating and Maintenance Instructions" and the product literature, including all warning contained therein;
d. Buyer/User's failure to test and monitor the functioning of the Product; and
e. Buyer/User's failure to determine and control the safety and cleanliness of discharged effluents, both gaseous and liquid, from the Product.

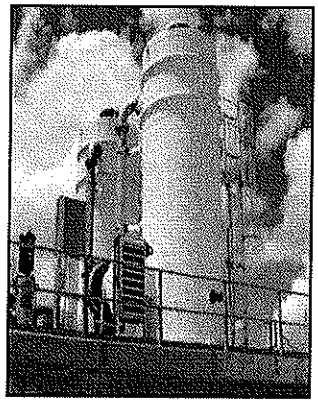
The Buyer/User hereby agrees to defend, hold harmless and indemnify the Seller and Seller's agents from and against all claims, suits, actions, and liabilities as enumerated above without limitation even if said claims, suits, actions, and liabilities are based upon actual or alleged negligence, breach of warranty (other than the limited warranty provided in paragraph 9 entitled: "Limited Warranty"), violation of any law, statute, ordinance, rule or regulation, or any other basis of liability on the part of Seller or Seller's agents.

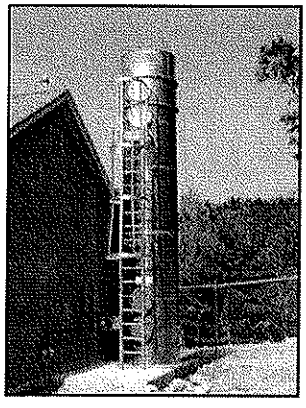
15. **Assignment:** No right or interest in this contract shall be assigned by Buyer/User without prior written agreement by the Seller. No delegation of any obligation by the Buyer/User shall be made without prior written agreement by the Seller.
16. **Modifications; waiver:** No Waiver, alteration or modification of any of the provisions hereof shall be binding on the Seller unless made in writing and agreed to by a duly authoried official of the Seller. No waiver by the Seller of any one or more defaults by the Buyer/User in the performance of any provision of this contract shall perate or be construed as a waiver of any future default or defaults whether of a like or of a different character.
17. **Changes & Improvements:** Seller reserves the right to make changes, and improvements in its Products at any time without notice. Where such change and improvements have been made, Seller shall not be obligated to incorporate such changes and improvements in Products previously sold to any customer, nor shall Seller be obligated to replace previously sold products with products incorporating such changes and improvements.
18. **Return of Goods:** Where Seller has provided prior written authorization, Seller will accept the return for credit or exchange of products which have been made to the specifications set forth in its catalogs and other literature, provided the product has not been altered or damaged. Products returned for credit will be subject to a 20% restocking charge. Return products must be shipped prepaid to Seller at the location noted in written authorization.
19. **Technical Services:** Upon request of Buyer/User, Seller will endeavor to furnish such technical advice as it has available in reference to the use of its products. Any technical advise furnished by Seller with reference to the use of its products is given and accepted at Buyer/User's risk and the Seller assumes no obligation or liability for the advice given or results obtained.
20. **APPLICABLE LAW:** The validity, interpretation and performance of all terms, conditions, warranties, disclaimers, indemnification and exculpatory provisions, and all other provisions described herein, and any purchase or sale made hereunder shall be governed by the law of New Jersey in force at the date this contract is made. Where not modified by the terms herein, the provision of Article 2 of the Uniform Commercial Code as enacted by the State of New Jersey shall apply to this transaction.
21. **SEVERABILITY:** If any provision or clause of this contract or application thereof to any person or circumstances is held invalid or unconscionable such invalidity or unconscionability shall not affect other provisions or applications of the contract which can be given effect without the invalid or unconscionable provision or application, and to this end the provisions of the contract are declared to be severable.
22. **WAIVER:** If the Seller, at its option, agrees to a waiver of any of the terms and conditions recited herein, such waiver shall not for any purpose be construed as a waiver of any succeeding breach of the same or any other terms or conditions of said contract; nor shall such a waiver be viewed as a course of performance.
23. **BUYER/USER'S ACKNOWLEDGMENT:** User/Buyer acknowledges that he has read both sides of this contract and accepts its terms.

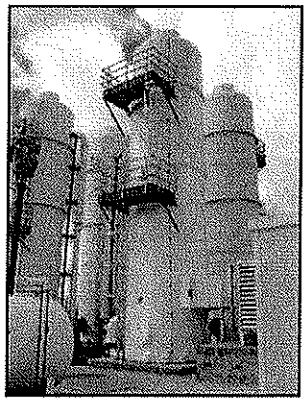
DELTA
Cooling Towers, Inc.

Municipal Products Division

Equipment for Municipal Water Treatment Applications





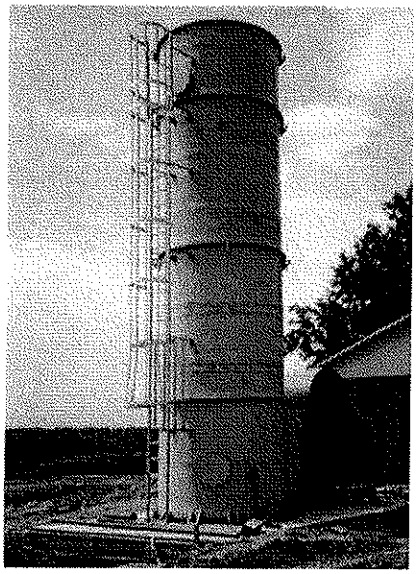


Statement of Qualifications

Delta Vanguard®
Packed Column Air Strippers

Delta Experience

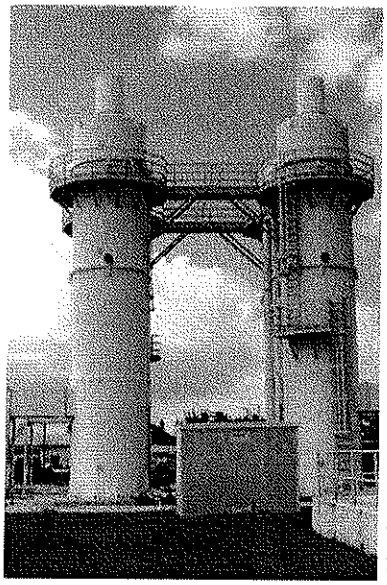
Vanguard® Air Strippers are custom designed up to 15 foot diameter and 4000 GPM per column. Delta has provided innovative and economical solutions to more than 400 installations since our first Air Stripping Tower was delivered over 20 years ago in 1981. Today, air stripping continues to be the preferred water remediation technology for removal of organic solvents, chlorinated hydrocarbons, fuel/gasoline hydrocarbons, degreasers, and certain other volatile organic chemicals (VOCs), because it is the most cost effective when considering Initial, Operating, and Maintenance costs. Delta's broad knowledge and vast experience enabled the company to continually develop and refine the Delta Vanguard® line of standard air strippers, which are suited for most applications. Delta's Vanguard® Air Stripper Systems are preferred for routine installations as well as for many applications with difficult to strip chemical compounds.



ΔS9-190F Air Stripping Tower for Removal of 99+% of Multiple VOC's from 70 gpm.

Partial List of Components Commonly Removed Via Air Stripping

- Trichloroethylene (TCE)
- Perchloroethylene (PCE)
- 1,1,1-Dichloroethane (1,1,1-DCA)
- Vinyl Chloride
- Carbon Tetrachloride
- BTEX
- MTBE
- Disolved Gases
- Hydrogen Sulfide (H2S)
- Carbon Dioxide (CO2)
- Radon



ΔS10-240F Air Stripping Towers for Removal of 99.5% of PCE from 6,000 gpm.

Major Benefits of Delta Air Strippers:

- Various Materials of Construction Available: Fiberglass, Stainless Steel or Coated Aluminum.
- Available with skid mounted options and accessories.
- Provided with proven packing design, column is normally pre-packed at our West Virginia factory prior to shipment.
- Modular, pre-assembled and light weight for simple, fast, economical installation.
- Flanged shell and oversized distributor allows for easy upgrade.
- Proven effective removal of contaminants considered difficult, and by some others, impossible to strip.
- Are usually the most economic treatment option.

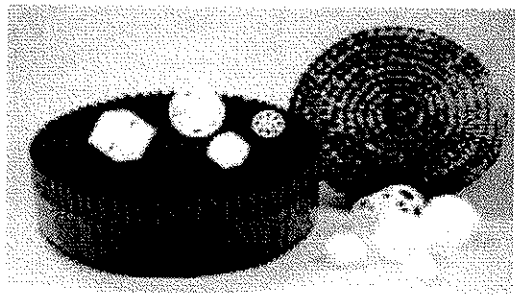
Quality and Cost Effective Solutions for Your Water Quality Issues

PH: 1.800.BUY.DELTA • WEB: www.deltacooling.com • EMAIL: sales@deltacooling.com

Air Stripping - The Packing Delta-Pak®

The heart of any air stripper is the packing or mass transfer media. Operational parameters, such as a compound's ease of removal, the mineral content of the water which can induce fouling, and air flow requirements as related to the necessity for vapor phase treatment, often dictate a preferred packing media. Delta designs and supplies strippers utilizing all packing types and will recommend the most suitable for your specific situation. Delta can provide any type and size of commercially available random packing, in addition to Delta-Pak®. Delta-Pak® is a highly efficient, low fouling propriety structured packing manufactured by Delta that is often the preferred mass transfer media.

Our media is Certified by NSF to standard 61.



Air Stripper Options

Air Emissions Controls

Delta offers appropriate vapor recovery systems including carbon absorbers and wet scrubbers.

Chemical Cleaning Systems

Delta developed this option to ensure long term operation, at maximum efficiency, and to minimize or eliminate the need for packing replacement.

Instrumentation, Controls and Telemetry

Delta provides control systems that integrate pressure, flow, overflow, fail-safe and transfer control systems for remote monitoring and data collection.

Corrosive Environments

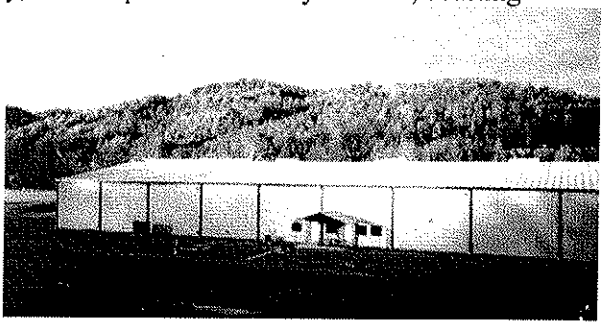
Delta designs major component in Fiberglass (FRP), Stainless Steel or Aluminum.

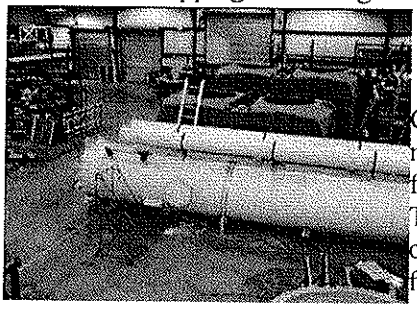
Pumping Stations and Packages

Delta offers a wide range of pumping and control options including redundant pumps, skid mounting and pre-wiring, pH adjustment, and turn-key skidded systems.

Delta's Philippi, West Virginia Manufacturing Facility

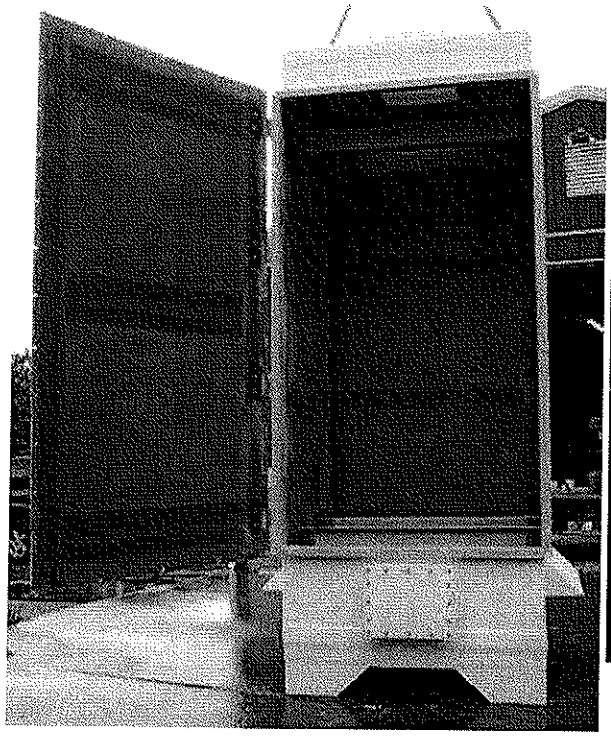
Delta's continued expansion required a new facility, which opened in January of 2002, boasting 40,000 square feet of storage, assembly, and fabrication area under the 27'-0" high roof. An additional 4.55 acres of storage area exists outside for material and equipment staging. Truck access into and out of the factory is through one large 14'-0" wide x 16'-0" high overhead door, and several smaller shipping / receiving doors.

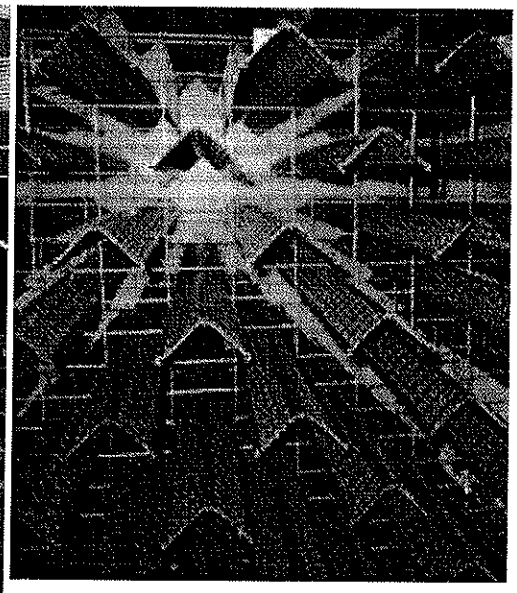




Our facility is a key to our ability to service your water treatment needs in a timely and cost effective manner, while ensuring the final product is of the best possible quality and workmanship. This vertically integrated manufacturing capability coupled with our unmatched experience in air stripping design puts Delta at the forefront when looking for a supplier to be responsive to a client's needs while ensuring a cost effective and on-time delivery.

BOX AERATOR - DISSOLVED GAS AND IRON REMOVAL





Owner:
Forth Ward Water Assoc.

Process Design:
500 gpm
90.0% CO2 Removal
Oxidize Iron

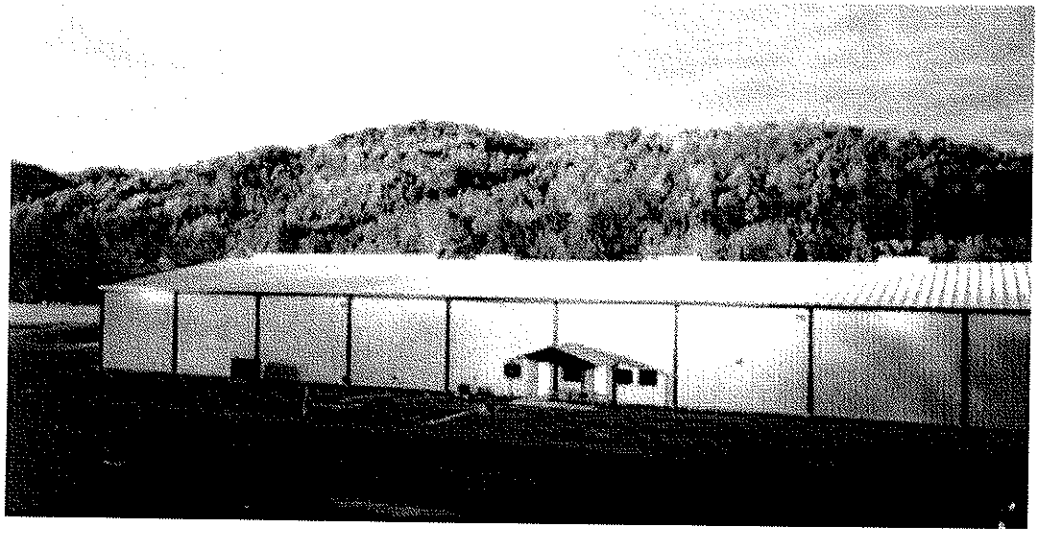
Site Location:
Albany, LA

Equipment:
Box Style Aeration Tower
Model A5-080SF

Delta Cooling Towers, Inc. designed and fabricated (1) One 5'-0" Square x 14'-0" Box Style Aeraton tower to treat potable water For the Fourth Ward Water Association in Albany, LA. The tower shell was fabricated from an NSF Resin System. The tower was supplied with a 0.75hp prop. fan rated for 2,400cfm @ 0.75" W.C. The main access door was hinged and the internal media consisted of individually removable angle slat fill. All of the tower internals were factory installed by Delta simplifying the installation process.

Delta Cooling Towers, Inc. • Municipal Products Division
41 PINE STREET • ROCKAWAY, NJ 07866 • PH: 1.800.BUY.DELTA • FAX: 1.973.586.2243
WEB: www.deltacooling.com • EMAIL: sales@deltacooling.com

DELTA COOLING TOWERS, INC.
MANUFACTURING FACILITY



The Sales, Engineering, and Headquarters of Delta Cooling Towers, Inc. is located in Rockaway, New Jersey. Our fully integrated manufacturing is located in Philippi, West Virginia. Delta had maintained it's manufacturing in New Jersey for over 30 years before outgrowing the facility and relocating to West Virginia.

The new facility, which opened in January of 2002, boasts 25,000 square feet of storage, assembly, and fabrication area under the 27'-0" high roof. An additional 4.55 acres of storage area exists outside for material and equipment staging. Truck access into and out of the factory is through one large 14'-0" wide x 16'-0" high overhead door, and several smaller garage doors.

The entire HDPE cooling tower product line is Rotationally molded, preassembled, inspected, and packaged for shipment inside this facility. The cooling tower product lines are the Paragon®, the Pioneer®, the Premier™, and the TM Series™ cooling tower.

The Vanguard® air stripping product line is also pre-assembled, shop packed, and Q.C. inspected prior to shipping to the customer. The air stripper shells are fabricated from aluminum, stainless steel, or FRP. The air stripper internal components are manufactured in house.

Thermoforming equipment is used to fabricate and assemble Delta-Pak® structured packing media. Random packings are purchased along with centrifugal blowers and instrumentation.

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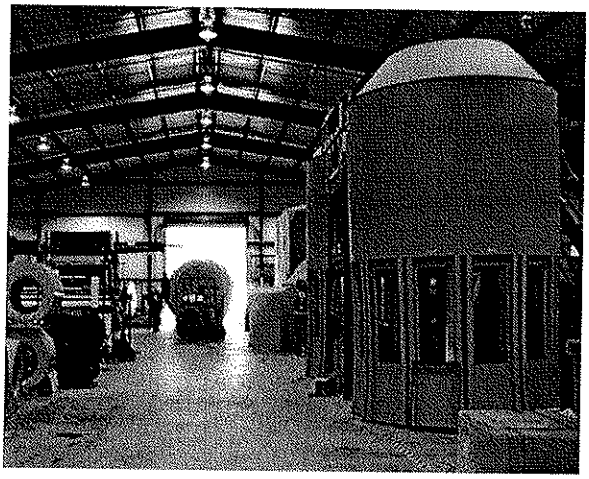
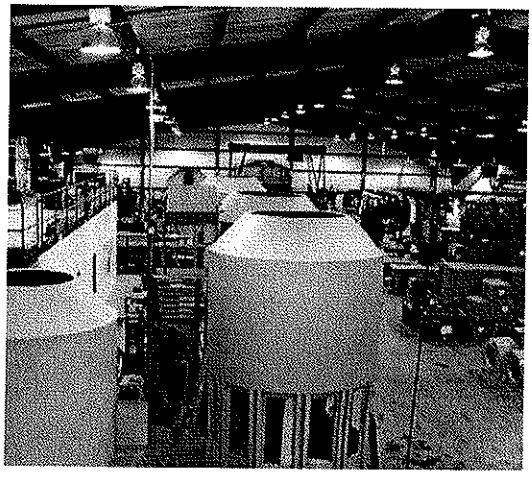
DELTA COOLING TOWERS, INC.
MANUFACTURING FACILITY





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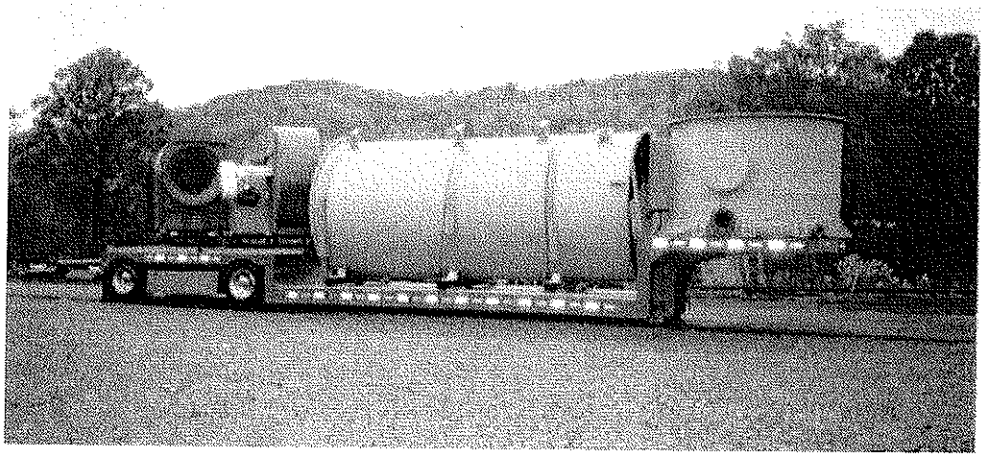

COMMITTED TO HIGH QUALITY ON-TIME DELIVERIES AND CUSTOMER SERVICE EXCELLENCE

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Web: www.deltacooling.com

DELTA COOLING TOWERS, INC.

PARTIAL LIST OF BOX STYLE AERATORS INSTALLATIONS

MODEL	OWNER / ENGINEER	LOCATION	Box Size	GPM	BLOWER CFM	PACKING MEDIA	CONTAMINANTS	REMOVAL EFFICIENCY
ΔFA-2.5-080SA	City of Bronaugh, MO	Bronaugh, MO	2'-6" x 2'-6"	125	600	PVC Angle	Free CO_2 and H_2S	90+% of Free H_2S
ΔA-7-080SF	City of Kentwood, LA	Kentwood, LA	7'-0" x 7'-0"	1050	5,200	PVC Angle	Free CO_2 and H_2S	90+% of Free CO_2 & H_2S
ΔA-9-120SA	City of Clare, MI	Clare, MI	9'-0" x 9'-0"	1400	7,600	PVC Angle	Free CO_2 & Iron	90+% of Free CO_2
ΔFA-6-060SSS	Rowley Water Department / Weston & Sampson	Rowley, MA	6'-0" x 6'-0"	852	3,000	PVC Angle	Free CO_2	90+% of Free CO_2
ΔA5-100SA	City of Pepperell, MA / Stantec	Pepperell, MA	5'-0" x 5'-0"	500	2,000	PVC Angle	Free CO_2 & Radon	90+% of Free CO_2 and Radon
ΔA2.5-050DSP	Little Manatee Water / Carter and Verplanck	Manatee, FL	2'-6" x 2'-6"	140	800	Delta-Pak	Free CO_2 and H_2S	85+% of Free H_2S & CO_2
ΔA4-070DSS	Rockaway Township, NJ / Moretrench America	Rockaway, NJ	4'-0" x 4'-0"	330	3,300	Delta-Pak	Radon	95+% of Radon
ΔA4.5-120SA	Scotts Hill, TN / Quinn Construction Corporation	Scotts Hill, TN	4'-6" x 4'-6"	200	2,100	PVC Angle	Free CO_2 and Iron	90+% of Free CO_2
ΔFA5-080SF	4th Ward Water District / Owen and White	Baton Rouge, LA	5'-0" x 5'-0"	500	2,400	PVC Angle	Free CO_2	90+% of Free CO_2
ΔA5-100SA	City of Pepperell, MA / Stantec	Pepperell, MA	5'-0" x 5'-0"	500	2,000	PVC Angle	Free CO_2 & Radon	90+% of Free CO_2 and Radon
ΔA5-120SF	Crosby, MS / Sphinx Construction	Crosby, MS	5'-0" x 5'-0"	350	2,500	PVC Angle	Free CO_2 and Iron	90+% of Free CO_2
ΔA5-080SF	Livingston Parrish, LA / Owen and White Inc.	Livingston Parrish, LA	5'-0" x 5'-0"	500	2,400	PVC Angle	Free CO_2	90+% of Free CO_2
ΔA5-080SF	Shivers WTF / Greenbrier Construction	Brookhaven, MS	5'-0" x 5'-0"	400	1,550	PVC Angle	Free CO_2 and Iron	90+% of Free CO_2
ΔA5.5-100SA	City of Chelmsford, MA / Stantec	Chelmsford, MA	5'-6" x 5'-6"	700	2,900	PVC Angle	Free CO_2	90+% of Free CO_2
ΔA6-080SF	Magnolia, MS / Parson and Sanderson	Magnolia, MS	6'-0" x 6'-0"	600	2,900	PVC Angle	Free CO_2 and H_2S	90+% of Free H_2S & CO_2
ΔA7-070SF	Progress Water Association / Owen and White	Lamar County, MS	7'-0" x 7'-0"	1,000	5,350	Random	Free CO_2	90+% of Free CO_2
ΔA9.5-055SF	Crossett WTF / Heritage Construction	Crossett, AR	9'-6" x 9'-6"	3,125	12,500	PVC Angle	Free CO_2 and Iron	90+% of Free CO_2

REV. 4 –1/20/16

EVOQUA
WATER TECHNOLOGIES

October 13, 2016

Alec Roberts
RMC Water and Environment
15510-C Rockfield Blvd., Suite 200
Irvine, CA 92618

Dear Alec,

Thank you for reaching out to Evoqua Water Technologies for information on treatment options for hexavalent chrome at the Northern California site.

Evoqua has put together this very high level assessment of the different options and budgetary costs.

As you are aware, there is not a “silver bullet” technology that works in all circumstances for chrome VI. There are a number of questions that can help a water purveyor determine the best solution for them.

- Do you have multiple contaminants that require treatment?
- Are there space constraints at your site?
- What is the technical level of your operators?
- Do you have water quality for:
  - Influent chrome VI
  - Calcium
  - Chloride
  - Nitrate
  - Sulfate
  - Alkalinity (as CaCO3)
  - Uranium
  - pH
  - TDS
- What is the flow rate of the well, and how many hours a day does it run?
- Do you operate the well seasonally?

A decision matrix based on these questions has been provided in Table 1 for treatment options. A brief description of these options is listed below.

I look forward to discussing these options more with you. Please call me for any questions.

Sincerely,

Cathy Swanson
Sales Engineer
562-217-0419

General Discussion of Chrome VI Treatment Options

Reverse Osmosis (RO) With RO, water is passed through a high pressure membrane. The contaminants are concentrated in a reject stream which is usually about 25 – 30% of the influent flow rate. The advantage of RO is that it can remove a wide variety of contaminants and lower total dissolved solids (TDS). The disadvantages are that RO can require a fair amount of pretreatment if the water is hard or has organics. Additionally, there is a large waste stream. The system can be costly to run and has a high degree of complexity.

Reduction, Coagulation, Filtration (RCF) This conventional treatment is based on reducing chrome VI to chrome III with the addition of iron, co-precipitating the chrome III and excess iron from the water, and then filtering the particulates with either multimedia filtration or microfiltration. RCF /RCMF works well in high flow rate scenarios. It does require a large amount of capital and footprint. There is a high amount of operator knowledge and interface required as well due to system complexity. There is a continuous solids stream of waste, and the solids stream generated is a hazardous waste.

Strong Base Anion Exchange (SBA) SBA is another ion exchange solution. SBA resins have shorter run lengths – any where from hours to months depending on water quality. Unlike WBA, the resin can be regenerated or re-used. Sulfate and chromate in the influent water compete for space on the resin, and high levels of sulfate will require more frequent regenerations. Nitrate in the influent water must also be accounted for with SBA because chrome VI will displace nitrate potentially causing nitrate sloughing above the nitrate MCL. This can be mitigated by having multiple treatment vessels to dilute nitrate spikes. An advantage of SBA is that no pH adjustment is necessary, so it works well with highly alkaline waters.

SBA Onsite Regeneration is done at the water purveyor's site. The resin is regenerated with a concentrated sodium chloride salt solution which drives the chrome VI from the resin and puts it into the brine. After regeneration, the resin is rinsed and then put back into service. The chrome laden brine is a hazardous waste and must be hauled off, or further treated with RCF / WBA or another process to reduce the volume of hazardous waste (i.e. hexavalent chrome.) The system footprint for this option is larger than WBA with salt storage, brine prep, brine reclaim, and spent brine holding tanks. Additional brine treatment will require more capital. Operators will need a good technical background as they are running a treatment plant, a regeneration plant, and possibly a brine reclaim plant.

Weak Base Anion Exchange (WBA) WBA has gotten a lot of attention because it has been the basis for costs in the California's MCL determination. WBA is an ion exchange resin which adsorbs the chrome VI in acidic conditions. The WBA resins last for a long time – depending on water quality it can average around a year or two in run length. The systems are quite simple, usually configured in lead/lag, and do not require much operator expertise. The systems are also unaffected by high sulfates as compared to SBA.

The systems are run in lead/lag configuration.

There are a few disadvantages with WBA as well. Preconditioning of the resin may be required depending on which resin is selected. Additionally, the WBA works best with a pH around 6, so influent waters need to be adjusted accordingly, and post treatment water is generally required to readjust back to the influent pH. This can be done with acid and caustic chemical addition or carbon dioxide gas (which makes carbonic acid) injection and subsequent stripping. Alkalinity concentrations will affect how easily the pH is able to be adjusted. Because of the nature of the resin, it also attracts uranium. There is no safety issue with accumulated naturally occurring uranium, but it does need to be treated as a source material when it is disposed. The spent resin is also a hazardous waste. Because of the waste rules, the spent resin is called a mixed waste (source material plus hazardous), as the resin will fail the CA WET or Federal TCLP test for hazardous waste. Turnkey service providers like Evoqua can handle the spent resin appropriately.

Discussion of Options Relative to Site in Northern California

In all cases, we looked at treating part of the water and blending. Blending effluent goal was 5 ppb of chrome VI.

SBA:

SBA is not a good choice at these locations. The sulfate levels are very high and would necessitate multiple regeneration cycles per day. Additionally, right after the regeneration cycle, the vessel will spike nitrate levels because the sulfate pushes off the nitrate. One approach to dealing with this phenomena at other sites is to have multiple treatment vessels that would dilute out the spike. Some sites would require more than 70 vessels to have enough water to dilute. This would not be feasible. Thus, costs for SBA are based on having the water go to waste for several bed volumes after regeneration so that a nitrate violation does not occur. The volume would need to be worked out on how much extra waste there is. That waste stream is not included in the O&M estimates.

Capital includes treatment vessels, resin, brine tanks,

RO:

More work needs to be put into this option. O&M costs are developed based on an estimated treatment cost with no organic pretreatment or softening pretreatment. These may be needed and would drive up the O&M costs. TDS is a Secondary Maximum Contaminant and only three of the wells are above the upper limit. Blending may be a better option to reduce TDS than using RO.

RCF:

RCF is based on using two reactors; ferrous sulfate addition and pH control is done in the first reactor, and sodium hypochlorite and pH control in the second reactor. There is then an equalization tank which feeds ultrafilter membranes. The membranes have a separate feed pump, backwash pump, and membrane skids. The membranes operate at 38 to 40 gfd flux with no redundancy. There is a backwash supply holding tank, a CPS feed tank, a sludge recycle pump, a polymer feed pump, and a filter press. The sludge storage tank holds enough sludge for an 8 foot press which will run about once per week.

O&M is based on ferrous sulfate addition, sludge disposal, and membrane costs.

WBA:

Options are given for two different resins; Dow PWA-7 which was used at the Glendale site in California, and ResinTech SIR 700. Both resins will have similar bed life. Both resins will load uranium. The PWA-7 does not have any early chrome leakage, but it does require a resin preparation step in Evoqua's facility. The SIR 700 will have early chrome VI leakage, but that will be adsorbed by the lag bed. There is a considerable price difference between the two resins.

Capital costs include resin for the initial fill, resin preparation, vessels, and chemical addition pumps.

O&M costs do not include chemical addition for pH adjustment. Note, adding acid and base to change the pH will increase the TDS levels. CO2 addition and stripping may be a better option, but is also not included. O&M includes resin replacement, resin preparation, and resin disposal assuming loading of uranium on the resin at less than 0.1%.

Please be advised that this budgetary information is a non-binding commitment, is being utilized for review and informational purposes, and does not constitute an offer for acceptance. A firm proposal, by Evoqua, would be contingent upon several items including: (i) resolution of mutually acceptable payment terms; (ii) Evoqua's satisfactory

completion of an anti-corruption due diligence review; (iii) a written agreement specifically acknowledging acceptance of terms and conditions mutually agreed upon by the parties; and (iv) subject to credit approval by Evoqua.

Please find the attached decision matrix and the cost table.

Budgetary Costs for Capital and O&M

Location	Total Production Capacity Flow (gpm)	Treated Flow (gpm)	SBA Capital	SBA Major Equip	SBA *O&M $/AF total	WBA with PWA-7 Capital	WBA with PWA-7 Major Equip	WBA with PWA-7 No of systems	WBA with PWA-7 O&M $/AF total	WBA with SIR-700 Capital	WBA with SIR-700 Major Equip	WBA with SIR-700 No of system	WBA with SIR-700 O&M $/AF total	RCMF Capital	RCMF Major Equip	RCMF No of systems	RCMF O&M $/AF total	RO O&M $/AF total
Well No. 1	1,400	1,120	$662,300	PTI SFTNR SEL TPLX ASME 84X84	$ 679	$ 2,008,500	HP1020IX Sys	2	$ 109	$ 1,237,200	HP1020IX Sys	2	$ 69	$ 1,874,000	Reactor and UF	2	$ 36	$ 1,601
Well No. 2	600	505	$494,400	PTI SFTNR SEL TPLX ASME 72X72	$ 1,149	$ 1,124,000	HP1020IX Sys	1	$ 115	$ 682,000	HP1020IX Sys	1	$ 110	$ 937,000	Reactor and UF	1	$ 38	$ 1,685
Well No. 3	1,500	1,375	$992,600	PTI SFTNR SEL TPLX ASME 120X96	$ 1,134	$ 2,008,500	HP1020IX Sys	2	$ 125	$ 1,237,200	HP1020IX Sys	2	$ 120	$ 2,811,000	Reactor and UF	3	$ 41	$ 1,835
Well No. 4	1,000	824	$776,000	PTI SFTNR SEL DPLX ASME 120X96	$ 1,335	$ 1,124,000	HP1020IX Sys	1	$ 112	$ 682,000	HP1020IX Sys	1	$ 107	$ 1,874,000	Reactor and UF	2	$ 37	$ 1,648
Well No. 5	800	700	$776,000	PTI SFTNR SEL DPLX ASME 84X84	$ 678	$ 1,265,600	HP1220IX Sys	1	$ 119	$ 869,000	HP1220IX Sys	1	$ 114	$ 1,874,000	Reactor and UF	2	$ 39	$ 1,751
Well No. 6	1,200	960	$754,000	PTI SFTNR SEL TPLX ASME 96X96	$ 1,298	$ 2,008,500	HP1020IX Sys	2	$ 109	$ 1,237,200	HP1020IX Sys	2	$ 104	$ 1,874,000	Reactor and UF	2	$ 36	$ 1,601
Well No. 7 (F)	1,200	1,011	$754,000	PTI SFTNR SEL TPLX ASME 96X96	$ 970	$ 2,008,500	HP1020IX Sys	2	$ 115	$ 1,237,200	HP1020IX Sys	2	$ 110	$ 1,874,000	Reactor and UF	2	$ 38	$ 1,685
Centralized Treatment	8,600	7,242	$2,740,400	Ten (10) PTI SFTNR SEL ASME 120X96	$ 970	$ 7,409,800	HP1220IX Sys	7	$ 115	$ 4,527,800	HP1220IX Sys	7	$ 110	$11,244,000	Reactor and UF	12	$ 38	$ 1,685

Cr 6 MCL:	10 µg/L
Cr 6 Target Concentratic	5 µg/L

* Please note, SBA O&M is understated because additional waste water will need to be hauled off with high nitrates
See discussion

Equipment Specifications
PTI Series Multimedia Filter
(72”-120” Diameter – High Flow Series)

GENERAL SYSTEM DESCRIPTION

General Description

The high flow series multimedia filters are designed and manufactured for industrial filter applications in sizes from 72” to 120” diameter tanks. The units are available in three configurations (Simplex, Duplex, and Triplex) and with three trim package options (Plus, Deluxe, and Select). Duplex and triplex configurations have multiple modes of operation to maximize operational flexibility.

These units are rugged, pre-engineered units that minimize expensive installation and start-up costs. They require simple utility connections, media loading, and minor configuration for immediate online service. Duplex and triplex configurations are shipped as individual units in order to minimize installation labor while maximizing orientation flexibility. The multimedia filter’s simple design maximizes the efficiency and repeatability of the unit during the service and wash modes in order to provide a truly reliable water treatment unit.

Mechanical Description

The multimedia filter consists of steel pressure vessel(s) that contain three grades of filtration media along with 2 support bed layers. The pressure vessels are sandblasted, lined with an NSF approved material, and painted with a durable epoxy coating. The piping and tank internals are constructed of Schedule 80 PVC or schedule 10, 316L stainless steel. All automatic valves are actuated pneumatically. Adjustable travels stops are included on the service, backwash, and rinse outlet valves in order to set the flows based on system requirements. A relief valve sized for thermal expansion pressure relief is also supplied on each tank.

Four structural steel legs, designed to meet International Building Code (IBC) to meet the requirements in 98% of North American installations, support each vessel. All interconnect piping on duplex and triplex systems are by others. Duplex and triplex systems do not include the last pieces of manifold on the waste and product piping that contain the flow elements and/or site glass. See P&ID for more details.

Air scour internal manifold is available on the high flow series multi-media filters. The Select trim package has the air scour internals included while the Plus and Deluxe trim package are designed to accept an optional, 316L SS air scour manifold (see Options section). All units have the necessary drain down piping, automated valves, etc. Any blowers, air bypass valves, check valves, etc. for the air scour is by others.

An overview of the configuration and trim packages available is on the next page.

Overview				
		Trim Packages		
Item	**Detail**	**Plus**	**Deluxe**	**Select**
Configurations	Simplex	X	X	X
	Duplex	X	X	X
	Triplex	X	X	X
Control		PLC/HMI	PLC/HMI	PLC/HMI
Vessel	Non - Code	X	X	X
	ASME	X	X	X
Face Piping	Material	PVC	316L SS	316L SS
Internals	Upper/Lower	PVC	PVC	316L SS
	Air Scour	Option Kit	Option Kit	X
Other	Turbidity Sensor	Option Kit	Option Kit	X
	DL Sight Glass	PVC	PVC	Borosilicate
	PSV (Thermal)	X	X	X
	Air Vent	Auto Valve	Auto Valve	Auto Valve

Electrical Description

For High Flow systems, the NEMA 4 Control Panel is mounted on Unit A. For Duplex and Triplex systems, individual NEMA 4 Solenoid Panels provide valve control on each additional vessel (Unit B, or, Unit B and Unit C). The Solenoid Panels contain the solenoid valves and terminal blocks for field wiring connections. High Flow vessels are free standing units (not skid mounted) and will require field wiring (by others) between the Control Panel and Solenoid Panel(s) for Duplex and Triplex systems. The single Control Panel will provide control and monitoring for Simplex, Duplex, and Triplex Filter configurations. The Control Panel is provided complete with a programmable logic controller (PLC) and a 7" Color, Touch Screen operator interface (HMI). An Ethernet connection is provided for communication with a SCADA or other control system.

Operational Description

The Multi-Media Filter has the following Modes of Operation and Wash Cycle steps based on the flow configuration and vessel arrangement (Simplex, Duplex, or Triplex configuration):

Simplex

- Modes of Operation: 3 (Offline, Service, and Wash)
- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Simplex operation consists of one vessel that will run in Service mode. Upon request of a Wash Cycle, the unit will wash accordingly. After completion of the Wash Cycle, the unit will return to Service mode.

Duplex Parallel

- Modes of Operation: 3 (Offline, Service, and Wash)
- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Duplex Parallel operation consists of two vessels that will both run in Service mode. Upon request of a Wash Cycle, both units will wash consecutively (Unit A, then, Unit B), leaving one unit online at all times.

Duplex Alternating

- Modes of Operation: 4 (Offline, Standby, Service, and Wash)
- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Duplex Alternating operation consists of two vessels that will run with one in Service mode, and one in Standby mode. Upon request of a Wash Cycle, the vessel in Service mode will wash, while the vessel in Standby mode will enter Service mode.

Duplex Pro-Flo (Plus, Deluxe, and Select trim packages)

- Modes of Operation: 4 (Offline, Standby, Service, and Wash)
- Wash Cycle Steps: 3 (Backwash, Settle, and Rinse)

Duplex Pro-Flo operation consists of two vessels that will run with one in Service mode (Primary vessel), and one in Standby mode (Secondary vessel). When product flow rises above a pre-defined setpoint, the vessel in Standby mode will enter Service mode. This vessel will return to Standby mode when product flow falls below the pre-defined return to standby setpoint. Upon request of a Wash Cycle, all units will wash consecutively. When a vessel is being washed, the remaining vessel will be in Service mode. After completion of the Wash Cycles, the vessel assignment will return to the state they were in prior to the initiation of the Wash Cycle.

Triplex Parallel

- Modes of Operation: 3 (Offline, Service, and Wash)
- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Triplex Parallel operation consists of three vessels that will all run in Service mode. Upon request of a Wash Cycle, all units will wash consecutively (Unit A, then, Unit B, then, Unit C), leaving two units online at all times.

Triplex 2 Online / 1 Standby

- Modes of Operation: 4 (Offline, Standby, Service, and Wash)
- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Triplex 2 Online / 1 Standby operation consists of three vessels that will run with two in Service mode, and one in Standby mode. Upon request of a Wash Cycle, the vessels in Service mode will wash consecutively. The vessel in Standby will enter Service mode. After completion of the Wash Cycles, the last vessel to be washed will enter Standby mode.

Triplex Pro-Flo

- Modes of Operation: 4 (Offline, Standby, Service, and Wash)

- Wash Cycle Steps: 7 (Vessel Drain, Air Scour, Settle, Vessel Refill, Backwash, Settle, and Rinse). For units without air scour, the first 4 steps are skipped.

Triplex Pro-Flo operation consists of three vessels that will run with a minimum of one in Service mode, and the others in Standby mode. When product flow rises above a pre-defined setpoint, the vessel in Standby mode will enter Service mode. This vessel will return to Standby mode when product flow falls below the pre-defined return to standby setpoint. Separate setpoints are provided for the 2nd and 3rd vessels. Upon request of a Wash Cycle, all units will wash consecutively (Primary vessel, Secondary vessel, then, Tertiary vessel). When a vessel is being washed, the remaining two vessels will be in Service mode. After completion of the Wash Cycles, the vessel assignment will return to the state they were in prior to the initiation of the Wash Cycle.

SYSTEM DESIGN SPECIFICATIONS

The design specifications for the PTI series multimedia filter are listed in this section.

PRODUCT OFFERING OVERVIEW:

	Plus, Deluxe, and Select Product Flow Rates											
	Min. Flow (2 gpm/sqft)			8 gpm/sqft			12 gpm/sqft			15 gpm/sqft		
Model Number	Simplex	Duplex*	Triplex**	Simplex	Duplex*	Triplex**	Simplex	Duplex*	Triplex**	Simplex	Duplex*	Triplex**
PTIM___72X60	57	113	170	226	452	679	339	679	1018	424	848	1272
PTIM___84X60	77	154	231	308	616	924	462	924	1385	577	1155	1732
PTIM___96X60	101	201	302	402	804	1206	603	1206	1810	754	1508	2262
PTIM___12060	157	314	471	628	1257	1885	942	1885	2827	1178	2356	3534

* While operating in a duplex alternating mode, the product flow rates are the same as a simplex unit.
** While operating in a 2 to 1 mode, the flow rates match a duplex unit. While operating in a progressive flow mode, the minimum flow rate matches

Nominal Removal Efficiencies:

Service Flux Rate	Anticipated % Turbidity Removal	
(gpm/sq ft)	**Particles > 40 µm**	**Particles < 40 µm**
8	96%	75%
12	80%	60%
15	70%	50%

DESIGN PARAMETERS:

Configuration	Simplex (Plus, Deluxe, and Select) Duplex (Plus, Deluxe, and Select) Triplex (Plus, Deluxe, and Select)
Feed Temperature	60°F
Feed Pressure	45 psig
Maximum Inlet Turbidity*	30 NTU (Nephelometric Turbidity Units)
Sizing: Service Flow Rate Backwash Flow Rate Rinse Flow Rate	 8 gpm/ft^2 12 gpm/ft^2 15 gpm/ft^2 Adjustable 6 gpm/ft^2
Air Scour	3 scfm/ft^2 @ 5 psig
Filter Bed Depth	30"

Freeboard	60% of the media volume (minimum)
Filtration Media	18” depth of anthracite (0.85 to 0.95mm average size) 8” depth of filter sand-quartz #20(0.45 to 0.55mm average size) 4” depth of #30-40 garnet (0.37mm average size)
Support Bed	3” depth of #8-12 garnet (1.8 mm average size) 2" over laterals - ¼" x ⅛" quartz

***** *If process is not within the given limit, then contact applications engineering for assistance.*

Rev. KRT – 04/16/14

HP®1020S IX SYSTEM

IX RESIN FILTER SYSTEM SPECIFICATION SUMMARY

HP®1020S IX Liquid Phase Systems are designed to treat a wide range of contaminated process streams. Piping and valves are configured for series, parallel, or vessel isolation flows. System includes Media inlet and outlet piping, and backwash capabilities. The system consists of two (2) adsorbers, with all piping, valves, and gauges assembled for ease of operation. Each adsorber is equipped with an underdrain capable of maximum process flow rate of 900 GPM.

EACH VESSEL:

Vessel Diameter	120”
Side Shell Height	96”
Overall Height (Approx.)	17’-10”
Maximum Working Pressure	125 psi @ 140 °F
Manway:	
Flanged at side shell	20”
Elliptical type at head	14” x 18”
Vessel Volume	6,650 gal.
Resin Capacity	424 Ft^3
Maximum Flow Rate	900 GPM
Design Criteria	ASME
Code Stamping	YES
Material	Carbon Steel
Supports	Legs and Baseplates (2 vessels)
Lifting	Lifting Lugs
Seismic	Current IBC
Interior Surface Prep	SSPC-SP5
Interior Surface Coating	Plasite 4110 35 mil dft min
Exterior Surface Primer	Epoxy 4 mil min dft
Exterior Surface Coating	Urethane 3mil min dft
Standard Color	Cashew (#9225)

CONNECTIONS:

Inlet / Outlet	8” 150# ANSI Flanged
Carbon Fill / Discharge	4” Kamlock
Utility Water / Air	2” Kamlock

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Evoqua Water Technologies LLC reserves the right to change the specifications referred to in this literature at any time, without prior notice.

Evoqua Water Technologies LLC

Tel: 866.613.5620
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HP1220 SYSTEM

RESIN SYSTEM SPECIFICATION SUMMARY

HP1220 Liquid Phase Systems are designed to treat a wide range of contaminated process streams. All piping and valves are configured for series, parallel, or vessel isolation flows. System includes inlet and outlet piping, and backwash capabilities. All vessels are typical construction for well head treatment. The system consists of two adsorbers, skid mounted, with all piping, valves, and gauges assembled for ease of operation. The adsorbers are equipped with underdrains capable of maximum flow rate of 1100 GPM.

EACH VESSEL:

Vessel Diameter	144”
Side Shell Height	60”
Overall Height (Approx.)	…15’-4”
Working Pressure	125 psi @ 150 °F
Manways: Flanged at side shell	20”
Elliptical type at head	14” x 18”
Vessel Volume	7520 gal.
Design Criteria	ASME
Code Stamping	YES
Material	Carbon Steel
Supports	Wide Flange Legs
Lifting	Lifting Lugs
Seismic	IBC 2007
Interior Surface Prep	SSPC-SP5
Interior Surface Coating	Plasite 4110 35 mil dft min
Exterior Surface Coating	Carboline
Standard Color	Cashew (Carboline #9225)

UNDERDRAINS:

External ring header	Carbon Steel
Septa Screens	8 ea, Xbox Design, 316L Stainless Steel, 4 ½” Dia x 10”

VALVE ASSEMBLY AND PIPING:

Piping:	
Process Piping	8” Schedule 40 Unlined Carbon Steel
GAC Transfer Piping	4” Epoxy Coated Carbon Steel
Valves:	
Process	8” Butterfly, Cast Iron Body w/SS Disk, Gear Operator
GAC Transfer	4” Flanged 316 Stainless Steel Full Port Ball Valve
Vent/Wash	2” Bronze Ball Valve
Sample Ports (3)	1/2” Bronze Ball Valve

SYSTEM WEIGHT:

System Shipping weight	45,000 lb
System Carbon Weight	40,000 lb
System Operating Weight	185,000 lb

Reduction Coagulation Filtration for hexavalent chromium

500 gpm. Equalization and feed by others.

Vantage UF

The Vantage UF removes solids by backwash, estimated 60 seconds of 1000 gpm backwash every 30 minutes for an overall water recovery of 93%. The 7% backwash volume (50,400 gallons per day) can be recovered, but the backwash is too dilute for direct dewatering. We could run through a CPS 50 to further concentrate the solids for filter press dewatering, and send the clear water back to the head of the system. We'll need to design around 550 gpm for a feed flow of 500 gpm.

Equipment list

RXP 1000 modified to flow 550 gpm. Two stages, 2 minutes reaction time each. Ferrous sulfate and pH control in RX-1, sodium hypochlorite and pH control in RX-2. Sodium hypochlorite residual needs to be low (0.5-2 mg/L free) to prolong the life of the membranes.

EQ 1000, used as a feed tank to the Vantage UF.

Vantage UFI24-D2. Separate feed pump, backwash pump, and two 24 membrane skids. Using the 1.5 mm modules and 38-40 gfd flux, no redundancy.

EQ 3200, used as backwash supply holding tank.

EQ 3200, used as CPS feed tank.

PS 50-D CPS duplex feed pump skid.

CPS 50 with a sludge recycle pump as well as a decant pump.

PCP 50 for polymer make down. We'll need to be careful on polymer feed, we won't want excess going back the feed of the UF. The sludge recycle will help reduce the amount of polymer fed to make a decent floc.

JP-8-630, 8 cubic foot filter press. The sludge storage tanks hold enough sludge for an 8 cubic foot press, which will run about once per week.

Reduction Coagulation Filtration for hexavalent chromium

500 gpm. Equalization and feed by others.

Vantage UF

The Vantage UF removes solids by backwash, estimated 60 seconds of 1000 gpm backwash every 30 minutes for an overall water recovery of 93%. The 7% backwash volume (50,400 gallons per day) can be recovered, but the backwash is too dilute for direct dewatering. We could run through a CPS 50 to further concentrate the solids for filter press dewatering, and send the clear water back to the head of the system. We'll need to design around 550 gpm for a feed flow of 500 gpm.

Equipment list

RXP 1000 modified to flow 550 gpm. Two stages, 2 minutes reaction time each. Ferrous sulfate and pH control in RX-1, sodium hypochlorite and pH control in RX-2. Sodium hypochlorite residual needs to be low (0.5-2 mg/L free) to prolong the life of the membranes.

EQ 1000, used as a feed tank to the Vantage UF.

Vantage UFI24-D2. Separate feed pump, backwash pump, and two 24 membrane skids. Using the 1.5 mm modules and 38-40 gfd flux, no redundancy.

EQ 3200, used as backwash supply holding tank.

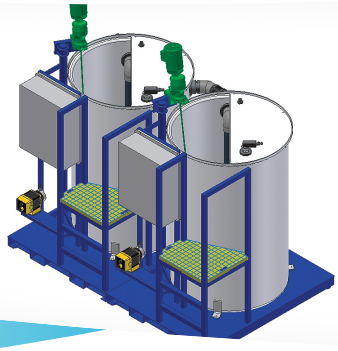
EQ 3200, used as CPS feed tank.

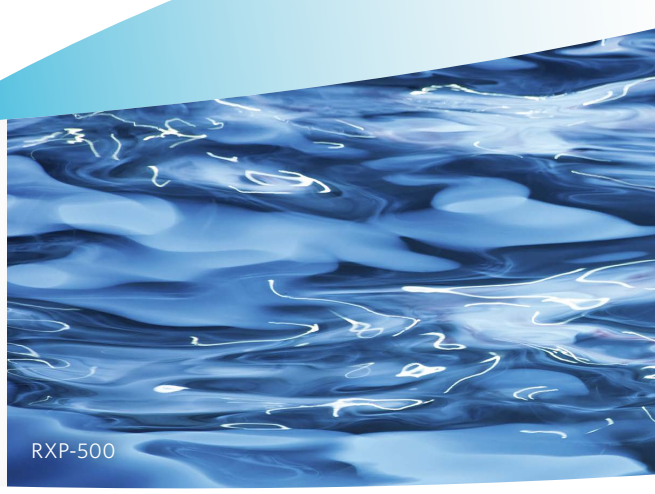
PS 50-D CPS duplex feed pump skid.

CPS 50 with a sludge recycle pump as well as a decant pump.

PCP 50 for polymer make down. We'll need to be careful on polymer feed, we won't want excess going back the feed of the UF. The sludge recycle will help reduce the amount of polymer fed to make a decent floc.

JP-8-630, 8 cubic foot filter press. The sludge storage tanks hold enough sludge for an 8 cubic foot press, which will run about once per week.





CHEMICAL REACTION SYSTEMS (RX AND RXP SERIES)

The Chemical Reaction RX (fiberglass tanks) and RXP (HDPE tanks) systems include two reaction tanks that are either skid-mounted or supplied with a catwalk frame and are completely piped and wired. The two tanks are designed to work in series. Water will be pumped or flow by gravity into the first tank and then on to the second tank. From the second tank the water flows either to the concentration tank of a microfilter or into the flocculation chamber of a clarifier or other separation device.

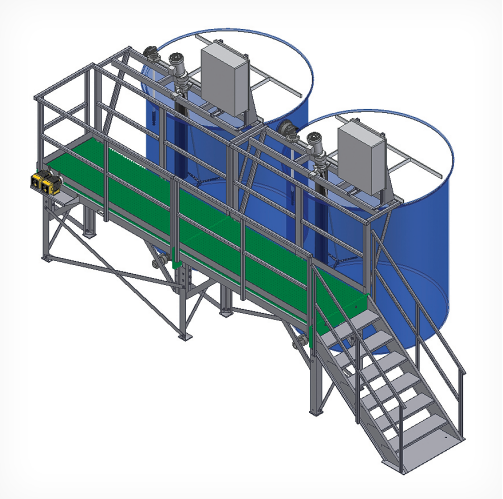
The basic reaction system configuration has one tank equipped with one Brawn mixer, one LMI® chemical feed pump, one GLI™ pH probe and one GLI pH transmitter. On RX/RXP systems less than 1,000 gallon capacity, the mixing tank is mounted on a skid with a frame.

The frame supports the mixer, probe and chemical pumps. The electrical control box, piping manifolds, conduit and wiring harnesses are also attached to this frame. When necessary, steps are supplied for operator access to the system.

Reaction systems above 1,000 gallons are designed with a freestanding catwalk frame. The mixing tanks are slid into place underneath the catwalk frame. Additional chemical feed packages can be added to the basic system.

Features

- Fully assembled at the factory
- Factory tested
- Units are either skid-mounted or catwalk integrated
- Units are match marked for ease of reassembly
- Rapid installation assured by skidded assemblies and mistake proof electrical connections



RXP-2000

CHEMICAL REACTION SYSTEMS

Model Number	RX/RXP-250	RX/RXP-500	RX/RXP-1000	RX/RXP-2000	RX-3000	RX-5000
Number of Tanks	Two	Two	Two	Two	Two	Two
Tank Material	FRP/HDPE	FRP/HDPE	FRP/HDPE	FRP/HDPE	FRP	FRP
Tank Volume (gallons)	250 gallons 0.95 m^3	500 gallons 1.9 m^3	1,000 gallons 3.8 m^3	2,000 gallons 7.6 m^3	3,000 gallons 11.4 m^3	5,000 gallon 18.9 m^3
Type	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical	Vertical Cylindrical
Method of Construction	Skidded	Skidded	Catwalk-Mounted	Catwalk-Mounted	Catwalk-Mounted	Catwalk-Mounted
Recommended Through-Put	20 gpm 4.5 m^3/hr	40 gpm 9.1 m^3/hr	80 gpm 18.2 m^3/hr	160 gpm 36.3 m^3/hr	240 gpm 54.5 m^3/hr	400 gpm 90.9 m^3/hr
Mixers	1/4 HP, 120/1/60, TEFC	1/3 HP, 460/3/60, TEFC	1/2 HP, 460/3/60, TEFC	1 HP, 460/3/60, TEFC	2 HP, 460/3/60, TEFC	2 HP, 460/3/60, TEFC

VALVES AND PIPING CONNECTIONS

Model Number	RX/RXP-250	RX/RXP-500	RX/RXP-1000	RX/RXP-2000	RX-3000	RX-5000
Outlet Connection	3" Male Pipe Stub	4" Male Pipe Stub	6" Male Pipe Stub	6" Male Pipe Stub	8" Male Pipe Stub	12" Flange
Drain Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve

INSTRUMENTATION

Model Number	RX/RXP-250	RX/RXP-500	RX/RXP-1000	RX/RXP-2000	RX-3000	RX-5000
pH Monitors	GLI pH Indicator Transmitter	GLI pH Indicator Transmitter	GLI pH Indicator Transmitter	GLI pH Indicator Transmitter	GLI pH Indicator Transmitter	GLI pH Indicator Transmitter
pH Probe	GLI Temperature Compensated	GLI Temperature Compensated	GLI Temperature Compensated	GLI Temperature Compensated	GLI Temperature Compensated	GLI Temperature Compensated
PLC	Evoqua	Evoqua	Evoqua	Evoqua	Evoqua	Evoqua

SKID REQUIREMENTS

Model Number	RX/RXP-250	RX/RXP-500	RX/RXP-1000	RX/RXP-2000	RX-3000	RX-5000
Mounting	Each tank is mounted on its own skid. Skids are interlocked for ease of reassembly.	Each tank is mounted on its own skid. Skids are interlocked for ease of reassembly.	Tanks are floor mounted with mixers and all other components mounted off the catwalks.	Tanks are floor mounted with mixers and all other components mounted off the catwalks.	Tanks are floor mounted with mixers and all other components mounted off the catwalks.	Tanks are floor mounted with mixers and all other components mounted off the catwalks.
Paint	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish	Near white metal sandblast + 2-3 mil primer + 3-5 mil finish
Dimensions (L x W x H)	110" x 72" x 85" (2,794 x 1,829 x 2,159 mm)	110" x 72" x 85" 2,794 x 1,829 x 2,159 mm	200" x 113" x 145" (5,080 x 2,870 x 3,683 mm)	200" x 133" x 145" (5,080 x 3,378 x 3,683 mm)	200" x 143" x 170" (5,080 x 3,632 x 4,318 mm)	220" x 165" x 170" (5,588 x 4,191 x 4,318 mm)
Shipping Weight	1,758 lbs (797 kg)	2,532 lbs (1,148 kg)	4,890 lbs (2,218 kg)	5,433 lbs (2,464 kg)	6,382 lbs (2,895 kg)	7,332 lbs (3,326 kg)
Operating Weight	5,928 lbs (2,689 kg)	10,872 lbs (4,931 kg)	21,570 lbs (9,784 kg)	38,793 lbs (17,596 kg)	56,422 lbs (225,592 kg)	90,732 lbs (41,155 kg)

EVOQUA WATER TECHNOLOGIES

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EQUALIZATION AND WATER STORAGE TANKS

The Equalization and Water Storage Tanks are specifically designed to be used with the transfer pump system. The tanks are used to provide the proper holding capacity before a wastewater treatment system or to hold purified water from an ion exchange or reverse osmosis system.

The tanks are available in either high density polyethylene (HDPE) or fiberglass (FRP). The tank can be supplied as either open top construction features or with a dome/cover.

The tanks come complete with a level control and all of the associated bulk head fittings.

Available Standard Options

- Ultrasonic Level Control
- Redundant Level Control
- Non-corrosive construction (HDPE or FRP)
- Level control included (floats)
- Integrate with other wastewater products

EQUALIZATION AND WATER STORAGE TANKS TANK (HDPE) SPECIFICATIONS

Model Number	EQ-250-HDPE	EQ-500-HDPE	EQ-1000-HDPE	EQ-1500-HDPE	EQ-3200-HDPE	EQ-6500-HDPE	EQ-9000-HDPE	EQ-10000-HDPE	EQ-12000-HDPE
Tank Volume	250 gallons 0.95 m^3	500 gallons 1.9 m^3	1,000 gallons 3.8 m^3	1,500 gallons 5.7 m^3	3,200 gallons 12.1 m^3	6,500 gallons 24.6 m^3	9,000 gallons 34.0 m^3	10,000 gallons 37.9 m^3	12,000 gallons 45.4 m^3
Material of Construction	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top	HDPE Dome Top
Drain Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve
Level Control	Float	Float	Float	Float	Float	Float	Float	Float	Float
Dimensions (Dia. x H)	43" x 59" 1,092 x 1,499mm	45-1/2" x 82-3/4" 1,156 x 2,102mm	64-1/2" x 88-1/4" 1,638 x 2,242 mm	64" x 126-1/2" 1,626 x 3,213mm	95-3/4" x 116-3/4" 2,432 x 2,965 mm	120" x 152-1/4" 3,048 x 3,867 mm	141" x 145" 3,581 x 3,683mm	141" x 159" 3,581 x 4,039mm	141" x 192" 3,581 x 4,877mm
Manway	8"	16"	16"	16"	16"	16"	16"	16"	16"
Shipping Weight	100 lbs (45 kg)	120 lbs (54 kg)	220 lbs (100 kg)	365 lbs (166 kg)	660 lbs (299 kg)	1,595 lbs (723 kg)	1,940 lbs (880 kg)	2,310 lbs (1,048 kg)	3,100 lbs (1,406 kg)
Operating Weight	2,185 lbs (991 kg)	4,290 lbs (1,946 kg)	8,560 lbs (3,883 kg)	12,875 lbs (5,840 kg)	27,348 lbs (12,405 kg)	58,307 lbs (26,448 kg)	77,000 lbs (34,927 kg)	85,710 lbs (38,877 kg)	103,180 lbs (46,802 kg)

EQUALIZATION AND WATER STORAGE TANKS (FRP) SPECIFICATIONS

Model Number	EQ-500-FRP	EQ-1000-FRP	EQ-1500-FRP	EQ-3200-FRP	EQ-6500-FRP	EQ-9000-FRP	EQ-10000-FRP	EQ-12000-FRP
Tank Volume	500 gallons 1.9 m^3	1,000 gallons 3.8 m^3	1,500 gallons 5.7 m^3	3,200 gallons 12.1 m^3	6,500 gallons 24.6 m^3	9,000 gallons 34.0 m^3	10,000 gallons 37.9 m^3	12,000 gallons 45.4 m^3
Material of Construction	FRP Open Top w/cover	FRP Open Top w/cover	FRP Dome Top	FRP Dome Top	FRP Dome Top	FRP Dome Top	FRP Dome Top	FRP Dome Top
Drain Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve	2" True Union Ball Valve
Level Control	Float	Float	Float	Float	Float	Float	Float	Float
Dimensions (Dia. x H)	42" x 66" 1,067 x 1,676 mm	60" x 84" 1,524 x 2,134 mm	72" x 84" 1,829 x 2,134 mm	96" x 108" 2,438 x 2,743 mm	96" x 210" 2,438 x 5,334 mm	120" x 186" 3,048 x 4,724 mm	120" x 210" 3,048 x 5,334 mm	144" x 168" 3,658 x 4,267 mm
Manway	8"	16"	24"	24"	24"	24"	24"	24"
Shipping Weight	230 lbs (104 kg)	406 lbs (186 kg)	560 lbs (254 kg)	947 lbs (430 kg)	1,950 lbs (885 kg)	2,200 lbs (998 kg)	2,730 lbs (1,238 kg)	3,745 lbs (1,699 kg)
Operating Weight	4,400 lbs (1,996 kg)	8,746 lbs (3,967 kg)	13,070 lbs (5,928 kg)	27,635 lbs (12,535 kg)	57,200 lbs (25,945 kg)	78,700 lbs (35,697 kg)	87,730 lbs (39,793 kg)	105,745 lbs (47,965 kg)

EVOQUA WATER TECHNOLOGIES

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VANTAGE® UFI ULTRAFILTRATION SYSTEMS

Vantage® UFI ultrafiltration systems from Evoqua Water Technologies offer a robust system designed to remove suspended solids and organic impurities from a variety of different water streams.

Ultrafiltration (UF) is quickly becoming the process of choice over conventional technology for the following reasons:

- Superior protection of downstream equipment (i.e. RO systems) to reduce fouling and extend equipment life
- UF membranes provide a physical and verifiable barrier to remove suspended solids
- Consistent quality regardless of feed water conditions
- SDI's typically less than < 2
- Smaller footprint by replacing multiple conventional treatment steps into one filtration step
- Fewer chemicals with less waste, resulting in lower operating costs

MEMBRANE DETAIL

Multibore® ultrafiltration (UF) membrane technology combines seven single capillaries into one, durable membrane fiber. This construction significantly enhances the physical strength and reliability of the membrane, virtually eliminating fiber breakage. With nominal pore size of 0.02 microns, the UF membrane efficiently removes turbidity, particulates, bacteria and pathogens delivering consistently high-quality water, independent of changes in the raw water quality. The modified polyethersulfone (PES) membrane is durable over a wide pH range and highly resistant to fouling by organic matter.

Evoqua Water Technologies offers two options of fiber diameters (0.9 mm and 1.5 mm fiber) that are optimized for your feed water. In general terms, the 0.9 mm fiber is used for source waters with average turbidities < 50 NTU (peak 100 NTU). The 1.5 mm fiber is used on higher turbitity waters (average > 50 NTU, peak 250 NTU) or for backwash waste recovery (water savings) applications.

MODULE DETAIL

At the heart of the Vantage UFI system is the Vantage LPU (low pressure ultrafiltration) module. Multibore fibers are bound together to form a filter module encapsulated into an economical low-pressure PVC housing. The unique design of the module reduces external piping and pipe supports by integrating the feedwater manifolds into the end cap of each module. Through an annular gap between the shell and distribution pipe, filtrate is collected or backwash is introduced into the module. This results in a nearly constant radial velocity across the module diameter leading to:

- Minimized fouling due to an efficient backwash impulse over the total module cross section
- Guaranteed module integrity since no o-rings are used to seperate the feed from the filtrate side
- Minimized process related movements thereby reduced mechanical strain on the fibers and maximized life expectancy

Vantage® UFI System Mid-Range Skid (12 module skid)

Vantage® UFI System Large-Range Skid (48 module skid)

VANTAGE® UFI SYSTEM CONFIGURATION

Vantage® LPU modules are manifolded together into racks and combined with pumps and controls to form a Vantage UFI system.

Vantage UFI systems are available in six models – 4, 8, 12, 24, 36 and 48 module racks. Additional configurations provide up to four racks (i.e. 4 x 24 module racks). Additionally, systems are available with:

- Evoqua or Allen-Bradley control packages with HMI touch screen interface
- Manual/auto backwashing strainer options
- Completely automated backwash and chemical-enhanced backwash capabilities
- VFD-controlled feed pumps for ease of operation and energy savings
- Completely skidded packages with short lead times

VANTAGE UFI MID RANGE SYSTEMS

Mid-range UFI systems (4, 8 and 12 module rack) are designed to treat flow rates from 13.5 to 61 m^3/hr (60 to 270 gpm).

Mid-range Vantage UFI systems include all major components (control panel, membrane modules, feed pump, strainer(s), backwash pump, instrumentation, valves and piping) mounted on a single a skid assembly. The skids are designed to provide maximum support and protection of UFI system components while allowing access for maintenance and operation.

VANTAGE UFI LARGE RANGE SYSTEMS

Large-range UFI systems (24, 36 and 48 module racks) can treat flow rates of over 225 m^3/hr (1,000 gpm), and consist of four seperate assemblies:

- Single feed water pump and pre-strainer skid
- Single backwash/chemical injection pump skid
- Module rack skid(s)
- Main system control panel (with leg kit)

Large-range UFI systems can be ordered with the following configurations:

- 24 Module racks can be ordered with up to four (4) skids
- 36 and 48 module racks can be ordered with up to two (2) skids

Each skid has a carbon steel frame with an industrial coating to support the major system components. These skids are designed to provide maximum support and protection of UFI system components while allowing access for maintenance and operation.

The feed water pump skid contains a motor starter/remote I/O panel, auto-backwashing strainer, instrumentation, pressure relief protection, valves and piping. The backwash water pump skid contains a control panel, chemical injection pumps, instrumentation, pressure relief protection, valves and piping. The module skid contains a control panel, membrane modules, flow controls, instrumentation, valves and piping.

Each Vantage UFI large range system contains a loose-shipped main control panel that interfaces with remote I/O panels located on the system pump and module rack skids.

VANTAGE UFI SYSTEM SPARE PARTS

Evoqua Water Technologies also offers standard spare parts kits and a variety of service packages for Vantage UFI systems. Because critical parts come from Evoqua, the original manufacturer, you will experience minimal downtime with less time spent trying to find replacements. We offer standard spare parts kits, including:

- Mechanical (includes module parts)
- Skid Electrical
- Electrical

VANTAGE UFI SYSTEM REMOTE MONITORING AND SERVICE

For even greater peace of mind, Evoqua Water Technologies offers service contracts to keep you up and running. Every standard Vantage UFI system is equipped with 24/7 remote monitoring capabilities, and our preventative checks save you time and money. All Vantage UFI units include the necessary Evoqua Link2Site® hardware for customer service connection (sold seperately). In order to activate Link2Site remote monitoring services, contact your local Evoqua service branch for availability in your region, subscription fees and/or service contract options to fit your needs.

MID RANGE VANTAGE® UFI SYSTEM OVERVIEW

	Product Flow Rates, m^3/hr/gpm			
Model	Nominal Flow at 59 LMH (35 GFD) Flux		Nominal Flow at 85 LMH (50 GFD) Flux	
	LPU MODULE XL 0.9 mm MB 60	LPU MODULE XL 1.5 mm MB 40	LPU MODULE XL 0.9 mm MB 60	LPU MODULE XL 1.5 mm MB 40
UFI04	14.3/63	9.6/42	20.4/90	13.6/60
UFI08	28.6/126	19/84	40.7/179	27/119
UFI12	42.7/188	28.4/125	61.1/269	40.6/179

LARGE RANGE VANTAGE® UFI SYSTEM OVERVIEW

	Product Flow Rates, m^3/hr/gpm*			
Model	Nominal Flow at 59 LMH (35 GFD) Flux		Nominal Flow at 85 LMH (50 GFD) Flux	
	LPU MODULE XL 0.9 mm MB 60	LPU MODULE XL 1.5 mm MB 40	LPU MODULE XL 0.9 mm MB 60	LPU MODULE XL 1.5 mm MB 40
UFI24D1_	85.6/377	57/251	122/538	81/358
UFI24D2_	171/754	114/502	245/1077	163/716
UFI24D3_	257/1131	171/753	367/1615	244/1074
UFI24D4_	342/1507	228/1004	489/2153	325/1432
UFI36D1_	128/565	85/376	184/808	122/538
UFI36D2_	257/1131	171/752	367/1615	245/1076
UFI48D1_	171/754	114/502	245/1077	163/716
UFI48D2_	342/1507	228/1004	489/2153	325/1432

* Product flow and flux rates listed above are based on the XL 0.9 mm and 1.5 mm modules, respectively and are established as a guideline. Performance when operating within these parameters varies based on feed water conditions. Under certain conditions, operation outside of these limits may be possible. Specific projections for each water condition must be run for each individual application to ensure proper performance.

FEED WATER GUIDELINES AND LIMITATIONS[1]

Feed Water Turbidity (NTU)	0-50 NTU Average, 100 NTU Peak (0.9 mm fiber) 50-160 NTU Average 250 NTU Peak (1.5 mm fiber)
TOC[2]	< 20 mg/L
pH	3-10
Oil and Grease	< 3 mg/L
Hydrogen Sulfide	< 0.2 mg/L
Fe/Mn	5 mg/L/1 mg/L (must be in suspended solids form)
Cationic Polymers	Non Detectable

[1] If any of the feed water parameters are not within the limits given, consult Evoqua Water Technologies for application assistance.

[2] Pretreatment by adding coagulants upfront of the UF may be required with feedwaters containing organics (TOC/DOC). Contact a Evoqua Water Technologies Application Engineer to determine if the optional coagulation dosing system is required.

NOMINAL DESIGN PARAMETERS

Mid-Range Configuration	4, 8 or 12 module
Large Range Configuration # of Modules per skid – # of Module Skids	24–1, 24–2, 24–3, 24–4; 36–1, 36–2; 48–1, 48–2
Inlet Pressure	0.34 bar (5 PSIG)
Inlet Temperature	20 °C (68 °F)
System Recovery	85 - 93% (typical)
Product Pressure	0.7 bar (10 PSIG)

PARAMETERS NOT TO EXCEED*

Inlet Temperature	2 - 40 °C (36 – 104 °F) Avoid abrupt changes in temperature (>1 °C/minute)
pH (Operation)	3 – 10 (1 – 13 for cleaning)
Inlet Pressure	0.7 bar (10 PSIG)
Transmembrane Pressure	
Filtration	0.1 - 1.5 bar (1.5–20 PSI)
Backwash	0.3 - 3.0 bar (5-40 PSI)
Ambient Conditions	
Temperature	2 – 40 °C (36 – 104 °F) Maximum
Humidity	Non-condensing conditions up to 90%
Exposure	Protect from sunlight and other UV sources

* If any of the feed water parameters are not within the limits given, consult Evoqua Water Technologies for application assistance.

DESCRIPTION

	Vantage® UFI Mid Range System		Vantage® UFI Large Range System
	Plus	Deluxe	Deluxe
General			
Number of Skids	1	1	3 - 7
Controls/Operator Interface	PLC/Color Touch Screen	PLC/Color Touch Screen	PLC/Color Touch Screen
Separate Remote I/O Panels and MCP			X
VFD Controlled Feed Pumps	X	X	X
Dual Manual Backwash (BW) Strainers	X		
Automatic BW Strainers		X	X
Optional (0.9 and 1.5 mm fiber diameters)	X	X	X
Instrumentation			
Mag Flow Meter (Feed)	X	X	X
Mag Flow Meter (BW)	X	X	X
Low/High Pressure Switches	X	X	X
Pressure Transmitters for TMP	X	X	X
Pressure Gauges	X	X	X
Feed Temperature	X	X	X
Feed/BW pH	X	X	X
Feed Water Turbity	X	X	X
Optional Filtrate Water Turbidity	X	X	X
Standard Options			
Chemical Enhanced Backwash Systems (CEB)	3	3	3
Auto High Point Air Bleed	X	X	X
Air Hookup for Integrity Testing (manual)	X	X	X
CIP connections	X	X	X
Link2Site® Remote Monitoring Services	enabled	enabled	enabled
Options To Be Ordered Seperately			
Coagulation Dosing Kit	X	X	X
Coagulation Reaction Time Skid (CRTS)	X	X	
Coagulation Reaction Time Tank (CRTT)			X

EVOQUA WATER TECHNOLOGIES

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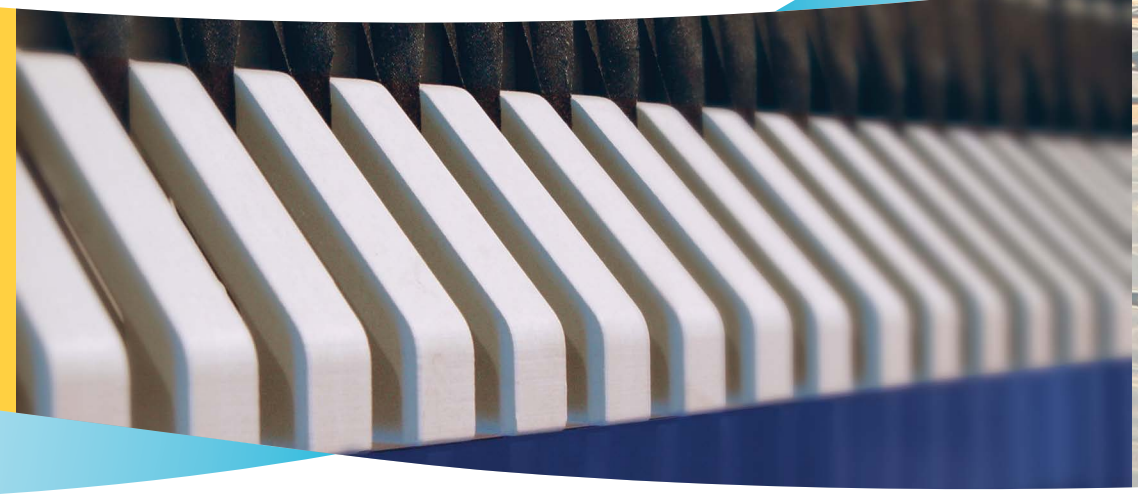
WATER TECHNOLOGIES



J-PRESS® SIDEBAR FILTER PRESS

1.5 m x 2.0 m Fully automatic with automatic cloth washer

J-PRESS® FILTER PRESS — THE INDUSTRY STANDARD

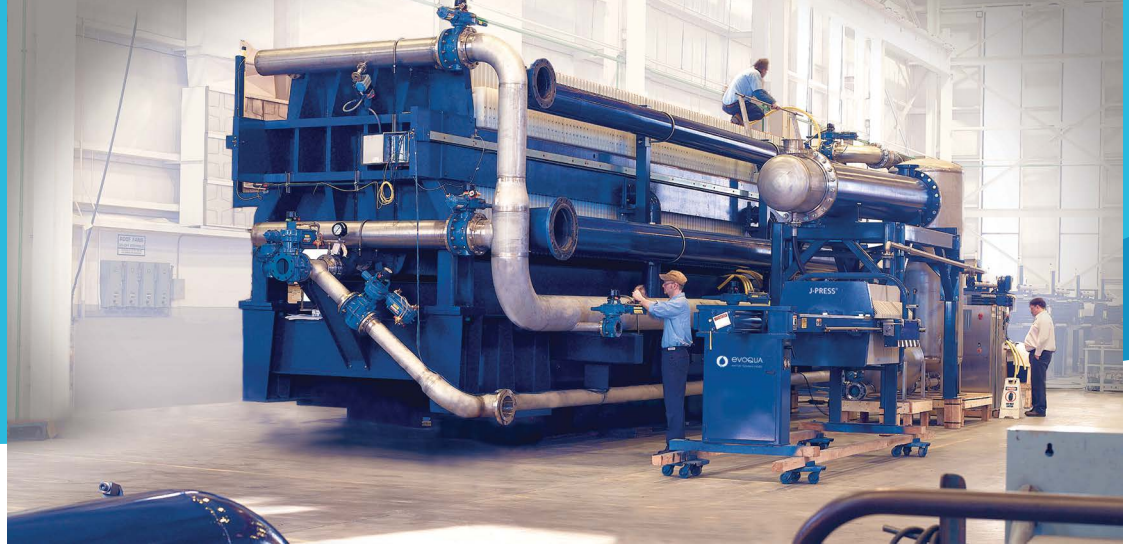
LIQUID/SOLID SEPARATION PROCESS

The J-Press® sidebar filter press is the cost-effective solution for producing high solids filter cake with extremely high clarity in the liquid effluent. Considered by industry professionals as the premier sidebar filter press, the J-Press filter press combines rugged construction, precision engineering, ease of operation and a wide range of features and options to tackle the most difficult dewatering problems.

The J-Press filter press is one of the most versatile dewatering devices on the market, being used in a wide variety of industrial and municipal applications. The J-Press filter press can be used to recover both solids and liquids from a waste or process stream. With superior materials of construction, the J-Press filter press is especially useful in the dewatering of aggressive acid and alkali suspensions.

Available in a wide range of sizes and styles, the J-Press filter press can be configured to provide a dewatering solution to most all process flows from as little as 25 gallons to 1,000,000 gallons per day. It produces consistent results under varying influent conditions.

1500 mm fully automatic with automatic cloth washer



The J-Press® filter press can be configured with highly sophisticated manifolds, controls and cake discharge systems, such as this 2.0 m x 2.0 m J-Press® filter press built for a prominent municipal wastewater treatment plant.

J-PRESS® FILTER PRESS, THE INDUSTRY LEADER

In 1978, JWI revolutionized the industry with the introduction of the J-Press® filter press. The J-Press filter press was the first to feature, in a single design, a self compensating air/hydraulic closure system for ease of maintenance, gasketed filter plates for virtually leak free dewatering, semi-automatic plate shifting for labor savings and safety, automatic pump controls for unattended operation and a superior paint system that provided the highest level of protection from corrosion. The J-Press filter press quickly set the benchmark for filter press performance.

In the ensuing years, the J-Press filter press evolved, offering options for fully automatic plate shifting, automatic cloth washing, PLC controls and a full complement of ancillary slurry processing and cake handling systems. Being the industry standard, the J-Press line of filter presses is now the most versatile on the market today, from a manual 250 mm pilot press that processes less than 2 lbs of dry solids per batch, to the monster 2.0 m fully automatic press that can produce over 10,000 lbs of dry solids per cycle.

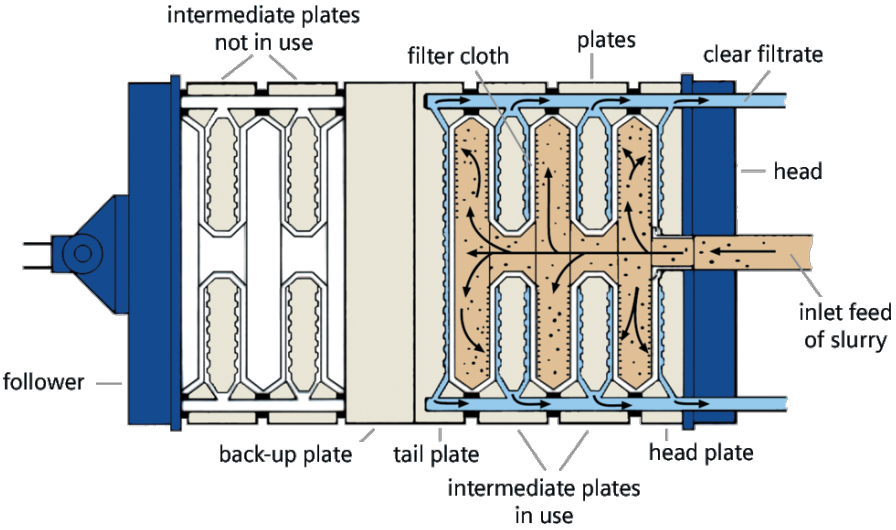
Evoqua sidebar presses are available in sizes ranging from 250 mm to 2.0 m designs, with working pressure ratings of 100 psi (7 bar) and 225 psi (16 bar).

ISO 9001:2000 QMS

The quality management system governing the manufacture of the J-Press sidebar filter press is ISO 9001:2000 certified.

630 mm semi-automatic

470 mm manual



Because the J-Press® filter press is a batch dewatering system, the press capacity can be easily adjusted by changing the effective volume of the filter pack. A back-up plate, in conjunction with the tail plate, can be inserted to reduce the number of chambers used during dewatering.

UNIFORM, CONSISTENT CAKE SOLIDS

The J-Press® filter press is simple to operate. A single switch activates the pneumatic or electrically actuated hydraulic system. The plate stack forms a series of chambers, each covered with a filter cloth. With the plate stack clamped tightly in place, a solids-laden slurry is pumped, under pressure, into the plate chambers through a central feed connection.

The plate chambers fill uniformly with solids while the pump pressure and flow keep the solids deposited on the vertical surfaces of the plate chambers. Liquid passes through the filter cloths as clean filtrate flows to the end of the press where it is collected at a common manifold.

The solids continue to fill the plate chambers and are compacted in the press by the feed pump until the chambers are completely full. The feed cycle is discontinued and an air blow down is initiated for 5-15 minutes to remove any freestanding water within the cake and the press. The hydraulic closure of the press is then retracted, the individual filter elements are separated and the solids are discharged as “dry” filter cake to an appropriate receptacle or conveyance system.

The J-Press filter press may also be equipped with diaphragm (or membrane) squeeze plates that allow for a mechanical compression of the filter cake, yielding higher dry solids before the cake is discharged from the filter press.

Gasketed plates form a tight seal due to o-rings around the recessed chamber and filtrate discharge eyes, allowing for a virtually leak free operation.

Filter clothes are available for all gasketed and non-gasketed plates (above); material and weave pattern are selected for your specific performance requirements.

Diaphragm (or membrane) plates feature flexible drainage surfaces that expand to exert additional pressure on the filter cake, further reducing moisture.

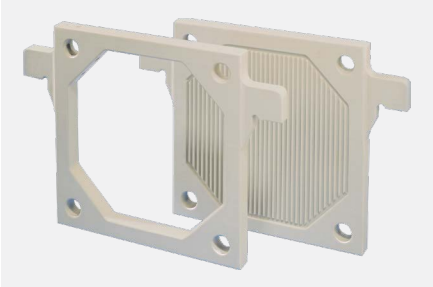
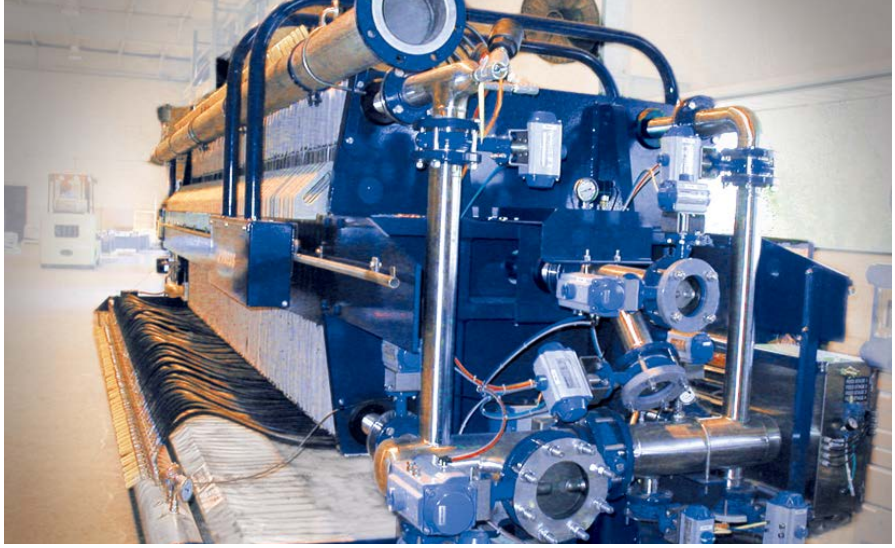


Plate and frame filter packs are available for polishing applications.

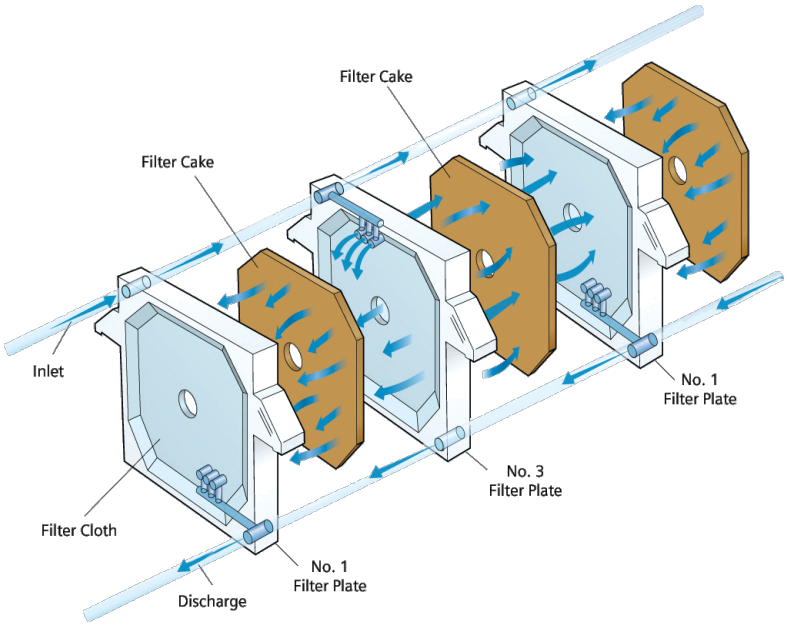


J-Press® feed and discharge manifolds are available in a variety of materials from PVC (above right) to stainless steel (above) to suit the application.

SUPERIOR FILTER PLATE TECHNOLOGY

Adding to the versatility of the J-Press® filter press is the large selection of filter plates available from Evoqua. Based upon the process operating demands, filter plates are selected for each specific application. Filter plates are available in corrosion resistant polypropylene, PVDF and nylon. Plates can be configured as gasketed or non-gasketed, diaphragm (membrane) squeeze, or plate and frame designs.

Like the J-Press filter press itself, the filter plates can be designed to withstand operating pressures up to 225 psi (16 bar).



CAKE WASH OR AIR BLOWDOWN

The inherent flexibility of the J-Press filter press makes it ideal for recovering solids, liquids or both. In processes where the filter cake may need treatment prior to discharge, the J-Press cake wash/air blowdown manifold can be used to force wash liquid through the cake. The manifold consists of piping and valves connecting the four corner filtrate ports into a common discharge pipe. By closing the appropriate valves, a wash liquid is pumped through the filter cake, and discharged out the diagonally opposed port. This can be followed by a compressed air blowdown, further removing moisture from the cake and filter plate drainage channels.

ENGINEERED PERFORMANCE AND OPERATING EFFICIENCY

1. MODULARIZED HYDRAULIC CLOSURE SYSTEMS

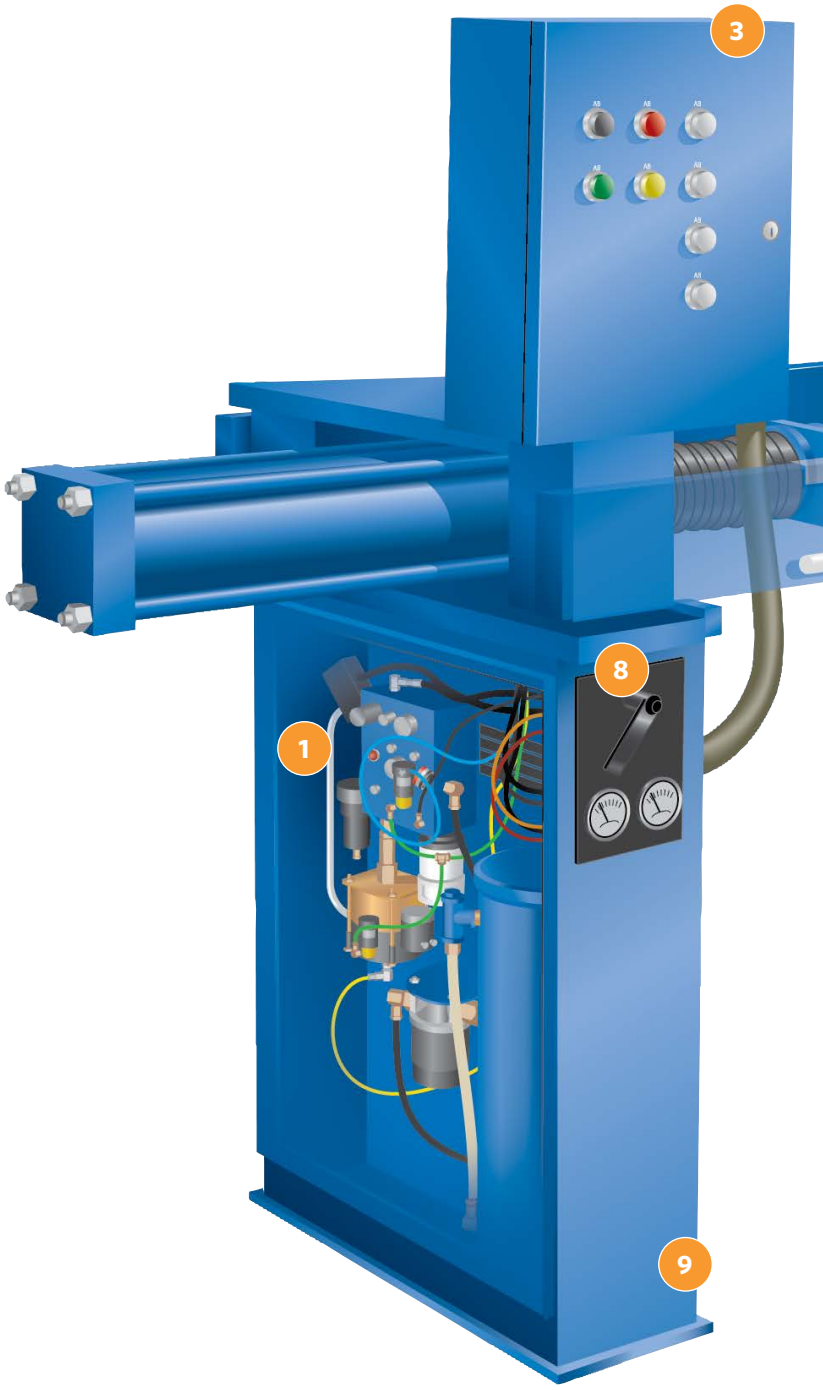
Available with either pneumatic or electric power, the modular power pack delivers up to 5,000 psi of hydraulic pressure to the hydraulic cylinder. The unit automatically compensates for thermal expansion and contraction of the filter pack due to changes in process temperature. Designed to minimize power consumption, the power pack features color coded connections for quick and easy removal and replacement during service and maintenance. The hydraulic pump and associated components are fully enclosed in a steel cabinet for protection from contamination and accidental damage, yet are easily accessible for maintenance through the full width cabinet door.

2. FUTURE EXPANDABILITY

The J-Press® filter press can be equipped with an optional expansion piece for future expansion of operating capacity with no need for costly sidebar replacements or frame exchanges. Expanding the capacity is as easy as adding additional filter plates.

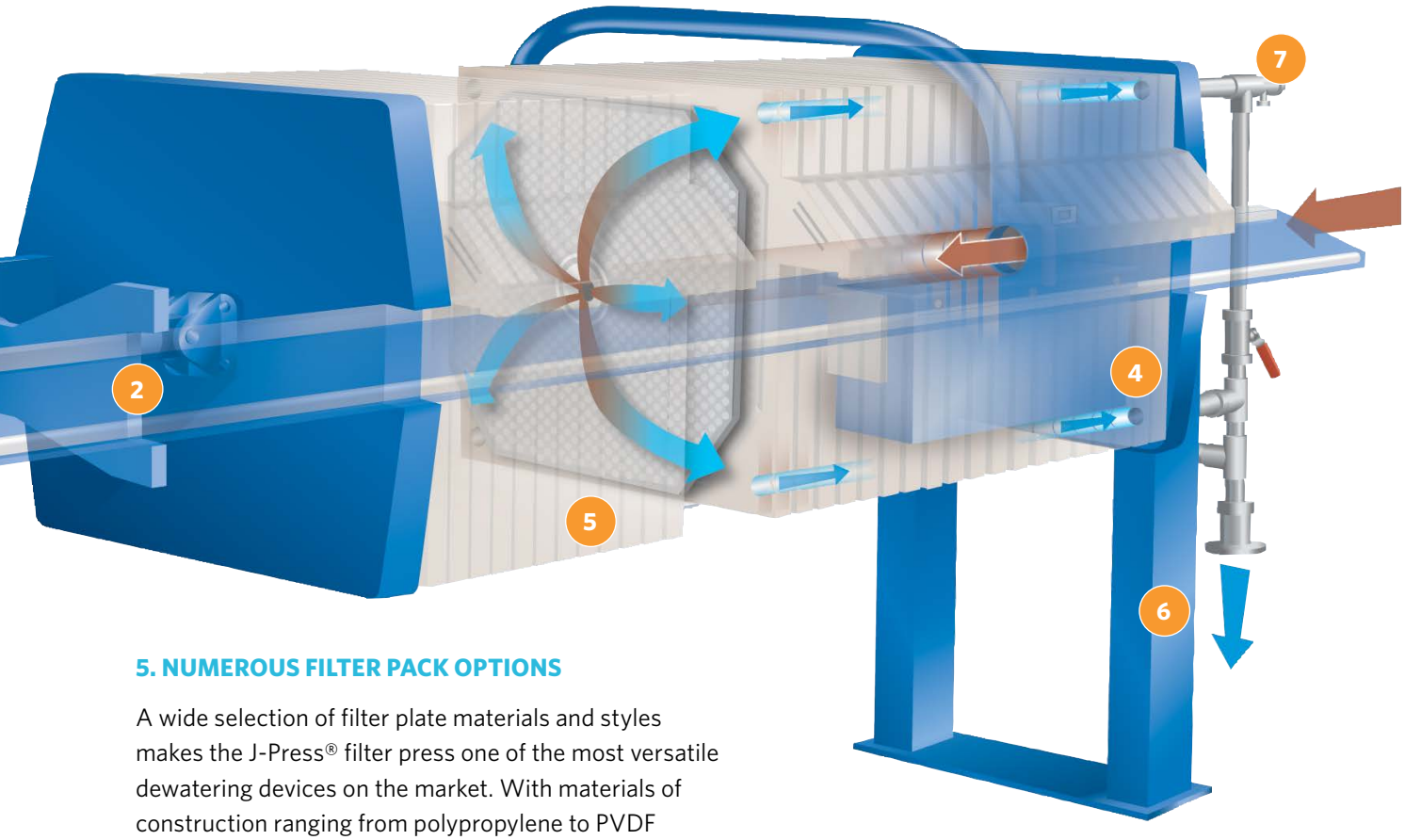
3. AUTOMATIC PUMP CONTROL SYSTEM (APCS)

For smaller presses, the APCS automatically controls the filling cycle, gradually increasing the feed pressure of the slurry feed pump to ensure a uniform formation of filter cake in the filter plate chambers. The uniform cake formation enhances the dewaterability of the incoming slurry. The APCS includes a hydraulic pressure safety device that shuts down the feeding cycle if a loss in hydraulic pressure occurs. For larger presses, filter press filling is controlled by a PLC.



4. PLATE SHIFTER/CLOTH WASHING

The J-Press filter press is available with either semi-automatic or fully automatic plate shifting systems (depending on size). The semi-automatic plate shifter is an operator driven plate shifting device that reduces manpower requirements during cake discharge. Further reductions in manpower are available with fully automatic shifting systems. The patented Evoqua pry, bump and weigh system offers the additional advantage of positive cake discharge from each chamber further reducing the requirement for operator interface with the filter press during cake discharge. A cloth washing system can also be added to the automatic plate shifting system to provide a periodic high pressure cleaning cycle for the filter cloths. Operating in as little as 20 seconds per plate, the automatic high pressure cloth washing system can restore the porosity of the filter cloths to like new condition. Washing the cloths at regular intervals not only improves performance but prolongs the working life of the cloth as well.



5. NUMEROUS FILTER PACK OPTIONS

A wide selection of filter plate materials and styles makes the J-Press® filter press one of the most versatile dewatering devices on the market. With materials of construction ranging from polypropylene to PVDF and nylon, the J-Press filter press can be designed to handle virtually any feed slurry no matter how corrosive or chemically aggressive. Filter plates are available in recessed gasketed, recessed non-gasketed and diaphragm (or membrane) squeeze designs that can dewater everything from the easiest metal hydroxide slurry to difficult organic solids. The J-Press filter press can readily adapt to changes in product and process applications by simply changing the filter cloths or the filter plates, giving the system great operational flexibility.

6. ROBUST FRAME CONSTRUCTION

The J-Press filter press is a ruggedly built unit made of fabricated steel plate. Precision alignment and machining of the structural components provide for even distribution of all pressures and stresses generated during operation. Frame strength is based upon the filter press operating pressure of either 100 psi (7 bar) or 225 psi (16 bar).

7. MANIFOLD PIPING

Like the filter plates, manifold piping is supplied in a variety of non-metallic and metallic materials suited to meet the rigors of the application. Manifolds can also be configured in a variety of inlet, discharge and valve options to maximize the versatility of the filter press. With the appropriate manifold, a filter press can be designed to perform both pre and post dewatering operations that enhance both the dewaterability of the material and the quality of the final cake.

8. CONTROL SYSTEMS

Filter press control can be as simple as a single switch for opening and closing to as complex as a fully integrated PLC with Ethernet or wireless capabilities for remote monitoring and operation. The PLC system provides the most advanced and complete press operation available, from automatic feed pressure adjustment, to cycle frequency, cake discharge, cloth wash and air blowdown.

9. SUPERIOR PAINT SYSTEM

Each J-Press filter press is sandblasted to an SSPC-10 near white finish before being primed and finished with a high quality, single coat aliphatic polyurea, fast clad DTM urethane paint system that results in a durable, chemically resistant finish averaging 6-9 mils in thickness (other paint systems are available on request).

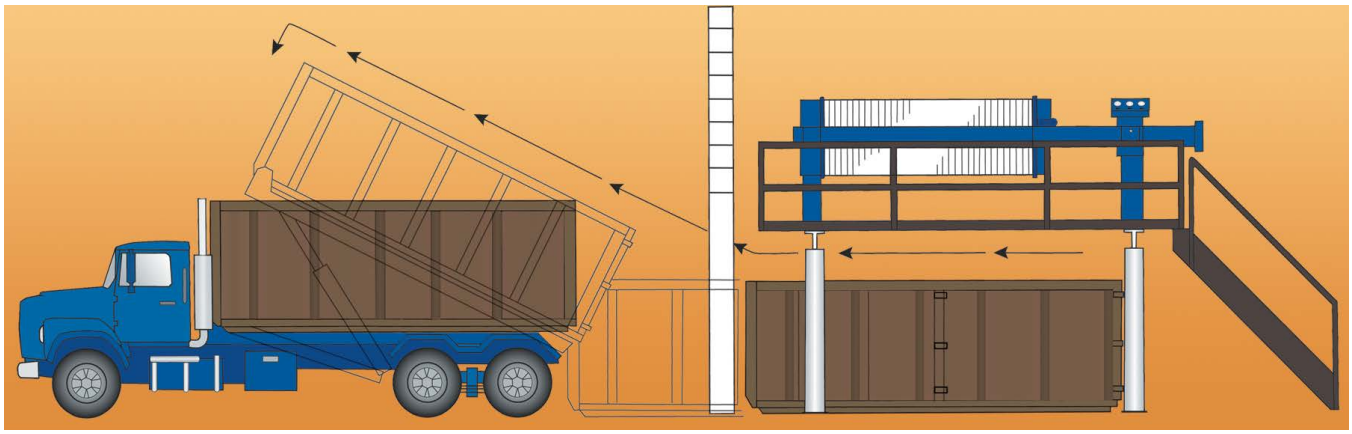
1.5 m x 2.0 m Fully automatic with automatic cloth washer

MATERIAL HANDLING SYSTEMS

The J-Press® filter press installation can be configured to accommodate a wide range of material handling systems for discharged cake. Dumpsters, equipped with casters and self-dumping forklift mounts are the most common method for smaller presses. The drum disposal system, also for smaller presses, allows easy removal of discharged cake. This system includes a series of chutes that catch the filter cake as it falls from the press and directs it into 55-gallon (200L) drums. The J-Press filter press is typically mounted on a platform, with catwalks, railings and stairs.

For larger presses, or presses that require transfer to downstream drying systems, Evoqua can engineer a belt or screw conveyance as an integrated component of your process configuration. Roll-off container and truck-loading systems are also available. Your Evoqua representative works closely with you to design, install and support the most efficient handling system for your specific needs.

Self-dumping dumpsters



Fully automatic cloth washer

Fully automatic plate shifter

Semi-automatic plate shifter

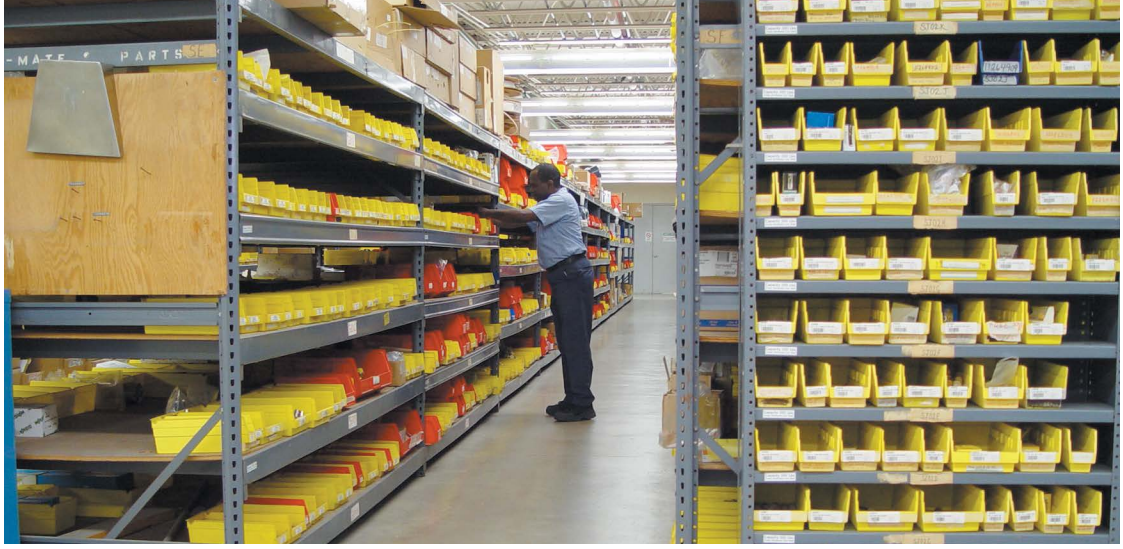
FULL RANGE OF FEATURES AND OPTIONS

Evoqua has the expertise and engineering capabilities to manufacture filter presses to meet the demands of your particular operation. Adaptability to applications, processes and capacities is the underlying value of J-Press® filter press. Features include:

- Full range of capacities: 250 mm to 2.0 m x 2.0 m
- Low and high pressure: 100 psi (7 bar), 225 psi (16 bar), higher pressure available — consult factory
- Standard plate packs: Non-Gasketed Plates, Gasketed Plates, Diaphragm Squeeze Plates, Plate and Frame
- Stainless Steel Sidebar Covers
- Closure Systems: Manual, Automatic Closure (Air/Hydraulic), Automatic Closure (Electric/Hydraulic)
- Control Systems: Standard Control Panel, Automatic Pump Control System, PLC Control
- Standard Manifolds: Air Blow Down Manifold, Double End Feed Manifold, Core Blow Down Manifold, Cake Wash Manifold, Precoat Manifold (other configurations available — consult factory)
- Expansion options available for future capacity
- Plate Shifting: Air Operated Semi-Auto Plate Shifter, Automatic Pry Shifter, Automatic Pry Shifter and Bump, Automatic Pry Shifter, Bump and Weigh (ACDDS), Multi-Plate Pull
- Automatic Cloth Washing
- Material handling: Filter Cake Dumpster, Extended Legs and Chute, Platform, Drum Disposal System, Platform, Roll-off Container System
- Cake Conveyors
- Drip Trays: Manual, Automatic
- Spread Leg Design
- Safety: Splash Curtain, Safety Guard, Safety Light Curtains, Deadman Control Button, Safety Tripwire, Hyd. Clamp Pressure/Feed Pump, Interlock, Hyd. Control System/Press, Pressure Interlock, Hyd. Clamp Pressure/Squeeze, System Interlock
- Custom Paint Systems: Nicklad® Coating

Optional expansion allows you to build your press to meet future needs, then increase capacity simply by adding additional filter plates.

Exclusive integrated hydraulic circuit technology automatically compensates for varying pressures and temperatures. The enclosed steel cabinet and leak-free design minimize maintenance.

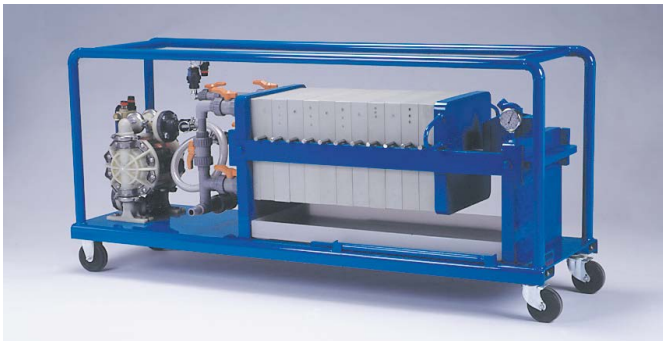


Our large parts distribution center ensures that many parts are available for same day shipment.

LABORATORY SERVICES—AN INFORMED DECISION IS THE BEST DECISION

Evoqua maintains a fully-staffed, state-of-the-art laboratory for determining the most effective liquid/solids separation techniques for your specific application. Capabilities range from feasibility testing of your materials to providing portable pilot units for on-site testing. This customer-focused resource produces tangible results. We can determine the most effective feed pressures, fill times, filter media and sludge conditioning.

In addition to ensuring a better informed equipment purchase, this valuable service is also available to help you maintain maximum performance of your J-Press® filter press.



Portable pilot filter press

AN ONGOING INVESTMENT IN YOUR SATISFACTION

Preventative Maintenance Services

We can customize a cost-effective program for your specific equipment, application, and environment that translates into lower maintenance cost and years of worry-free operation.

Parts Repair Service

Our professional service staff can quickly and reliably answer your technical questions and troubleshoot your specific requirements, schedule parts shipments, and arrange for an on-site service call. Our factory-trained and qualified service engineers travel throughout the world to help ensure equipment runs efficiently. From basic maintenance to complex Program Logic Control (PLC) interfaces and beyond, we have the experience and capability.

Refurbishment Services

We can provide a partial or complete rehabilitation of your equipment to a warranted like-new condition, at your site or ours.

Aftermarket Services

- Factory-based customer service support
- Expert technical consulting
- Same-day shipment on many service and spare parts
- Worldwide repair and preventative maintenance services
- Emergency support services
- Equipment retrofits, upgrades, and refurbishments
- Training
- Testing, evaluative and customized services

For more information on our Aftermarket Services, call 800.245.3006.

SPECIFICATION/SELECTION CHARTS

The following formula may be used for establishing J-Press® filter press volume (ft^3) (L) for most dewatering applications:

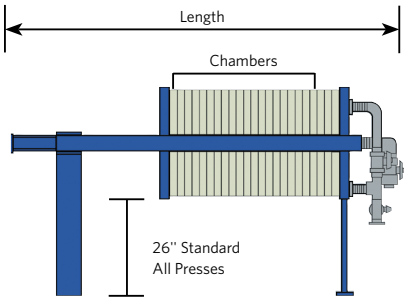
$$\text{Total Filter Press Volume } (ft^3)\ (L) = \frac{\text{Total volume of product feed (gallons) (liters)} \times \text{\% solids concentration of product feed*} \times \text{8.34 (lbs per gallon of water) (1kg/L) (density of water)} \times \text{specific gravity of feed slurry}}{\text{or}} = \text{lbs (kg) dry solids}$$

$$\frac{\text{Density of wet filter cake** } (lbs/ft^3)(kg/L) \times \text{\% dry solids content of filter cake*}}{} = \text{cake density } (lbs/ft^3)(kg/L) \times \text{\% cake solids}$$

* % concentration should be expressed in decimal form (e.g. 2% = .02).
**Density of wet filter cake = Specific gravity of wet filter cake x the density of water

For dewatering applications where feed solids are less than 1%, the dewatering area is the controlling parameter rather than volume. For such applications, contact Evoqua for size recommendations. Also, for advice on sizing for any application, contact Evoqua or our authorized representative.

PRESS	MEASUREMENT	MINIMUM	MAXIMUM
250 mm	**Volume (ft^3)**	0.1	0.4
	Volume (L)	2.8	11.3
Height 15" (381 mm)	**Length (in)**	24.0	38.0
Width 18.5" (470 mm)	**Length (mm)**	607.0	975.0
470 mm	**Volume (ft^3)**	0.5	4.0
	Volume (L)	14.2	113.0
Height 45.8" (1162 mm)	**Length (in)**	41.0	93.0
Width 33.0" (838 mm)	**Length (mm)**	1041.0	2362.0
630 mm	**Volume (ft^3)**	2.0	8.0
	Volume (L)	57.0	227.0
Height 51.0" (1299 mm)	**Length (in)**	85.0	129.0
Width 36.0" (916 mm)	**Length (mm)**	2168.0	3277.0
800 mm	**Volume (ft^3)**	8.0	25.0
	Volume (L)	227.0	708.0
Height 58.0" (1473 mm)	**Length (in)**	122.0	196.0
Width 43.5" (1105 mm)	**Length (mm)**	3099.0	4978.0
1000 mm	**Volume (ft^3)**	25.0	55.0
	Volume (L)	708.0	1558.0
Height 66.5" (1689 mm)	**Length (in)**	175.0	260.0
Width 51.5" (1308 mm)	**Length (mm)**	4445.0	6604.0
1200 mm	**Volume (ft^3)**	50.0	125.0
	Volume (L)	1416.0	3540.0
Height 74.5" (1892 mm)	**Length (in)**	217.0	356.0
Width 60.0" (1524 mm)	**Length (mm)**	5512.0	9042.0
1500 mm	**Volume (ft^3)**	130.0	270.0
	Volume (L)	3682.0	7646.0
Height 95.7" (2432 mm)	**Length (in)**	313.0	500.0
Width 74.9" (1903 mm)	**Length (mm)**	7950.0	12,700.0
1.5 x 2.0 M	**Volume (ft^3)**	275.0	350.0
	Volume (L)	7788.0	9912.0
Height 136.6" (3470 mm)	**Length (in)**	430.0	507.0
Width 79.0" (2007 mm)	**Length (mm)**	10,922.0	14,097.0
2.0 x 2.0 M	**Volume (ft^3)**	300.0	600.0
	Volume (L)	8496.0	16,992.0
Height 106.0" (2692 mm)	**Length (in)**	405.0	562.0
Width 137.0" (3480 mm)	**Length (mm)**	10,287.0	14,275.0



NOTES:

- Based on 32 mm cake thickness, 100 psi (7 bar)
- Additional sizes and capacities available — consult factory.
- All dimensions are approximate and should only be used for reference.
- Dimensions do not include optional equipment such as plate shifters, cloth washers or piping manifolds.

181 Thorn Hill Road, Warrendale, PA 15086

+1 (866) 926-8420 (toll-free) **+1 (978) 614-7233** (toll) **www.evoqua.com**

Nicklad and J-Press are trademarks of Evoqua, its subsidiaries or affiliates, in some countries. CSA ia a trademark of the Canadian Standards Association.

Product is covered by U.S. patent no. 5674384.

All information presented herein is believed reliable and in accordance with accepted engineering practices. Evoqua makes no warranties as to the completeness of this information. Users are responsible for evaluating individual product suitability for specific applications. Evoqua assumes no liability whatsoever for any special, indirect or consequential damages arising from the sale, resale or misuse of its products.

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FKC Dewatering Capacities for Hexavalent Chromium Treatment Project

Location	Flow Rate	Inlet Solids	Dry Lbs. / Day	Dry Lbs. / Week	BHX 200 - Hr/ Week Operation	BHX 300 - Hr/ Week Operation	BHX 400 - Hr/ Week Operation
Well #1	13933.33	3.0%	3486.12	24402.84	7.1	4.7	147.0
Well #2	209.00	3.0%	1743.06	12201.42	3.5	2.3	73.5
Well #3	585.00	3.0%	4878.90	34152.30	9.9	6.6	205.7
Well #4	334.00	3.0%	2785.56	19498.92	5.6	3.8	117.5
Well #5	292.00	3.0%	2435.28	17046.96	4.9	3.3	102.7
Well #6	376.00	3.0%	3135.84	21950.88	6.3	4.2	132.2
Well #7	418.00	3.0%	3486.12	24402.84	7.1	4.7	147.0
Centralized Treatment	2756.00	3.0%	22985.04	160895.28	46.5	31.0	969.2

FKC BHX Skids System	Capacity Lbs. / Hr.
Andritz D6LX	3460
BHX 300	5195
BHX 400	166

BHX 200 Skid System		
Screw Press		
Flocculation Tank		
Sludge Pump		
Polymer System		
Control Panel		
Skid Mounted		
Total Delivered Price	$	145,000.00

BHX 300 Skid System		
Screw Press		
Flocculation Tank		
Sludge Pump		
Polymer System		
Control Panel		
Skid Mounted		
Total Delivered Price	$	165,000.00

BHX 400 Skid System		
Screw Press		
Flocculation Tank		
Sludge Pump		
Polymer System		
Control Panel		
Skid Mounted		
Total Delivered Price	$	187,000.00

Sunny Huang

From: chelsea.crawford@parker.com
Sent: Monday, November 7, 2016 10:23 AM
To: Alec Roberts
Cc: mark.meine@parker.com
Subject: Groundwater Cartridge Filter RFQ
Attachments: MP Filter Vessel 2012_dhp-na.pdf; Honeycomb HFT_dhP-NA.pdf

Hello Alec,

I am assuming your request is for a typical PreRO application thereby requiring 5 micron nominal filtration. My recommendations are as follows:

1000 GPM System
Vessel
6LMP52H-4-8FK1

- Passivated 316 Stainless Steel
- 52 cartridges
- 40" length cartridges (accepts double open end or single open end)
- Horizontal configuration
- 8" Flange connections

Budget List per vessel: $26K ea
Standard Lead Time: 40 working days, from receipt of PO and approved drawing

6600 GPM System
Vessels (2 required in parallel to accommodate full flow rate)
6LMP176H-4-14FK1

- Passivated 316 Stainless Steel
- 176 cartridges
- 40" length cartridges (accepts double open end or single open end)
- Horizontal configuration
- 14" Flange connections

Budget List per vessel: $60K ea
Standard Lead Time: 40 working days, from receipt of PO and approved drawing

The following cartridge recommendation is suitable for both aforementioned housings.

Cartridge Filter Elements
M23R40A-TX

- FDA Grade string wound Polypropylene
- 5 micron @ 90% retention efficiency
- Buna-N O-ring 222 / Flex fin end configurations

Budget List per piece: $23.26 ea
Standard Lead Time: 5 working days

Please contact me any time by phone or e-mail should you require more information.

Thank you,

Chelsea Crawford, Bsc Eng
Territory Manager - Western United States
Industrial & Microelectronics
Parker-Hannifin Corporation
domnick hunter Process Filtration - North America
2340 Eastman Avenue
Oxnard, CA 93030
cell 916 221 2294
chelsea.crawford@parker.com

www.parker.com/processfiltration

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LAMELLA® EcoFlow™ GRAVITY SETTLER

PRELIMINARY BUDGET SIZING
RMC WATER AND ENVIRONMENT, CA

APPLICATION: **FILTER BACKWASH**

DESIGN DATA:

Flow:	672	USGPM =	0.97	USmgd	pH :	TBC
Feed quality:	250	mg/L suspended solids	(TBC)		Temp (°F)	TBC °F
Overflow quality:	20	mg/L suspended solids	(TBC)		Chlorides (mg/l):	TBC mg/L

One (1) model LGS 1500/55 LAMELLA® GRAVITY SETTLER
complete with flashmixer/flocculator

Plate area:	per unit:	1500	ft²	Total:	1500 ft²
Effective Settling area:	per unit:	1500	ft²	Total:	1500 ft²
Loading rate:		0.45	USgpm/ft²	Plate Efficiency:	100%
Sludge hopper capacity each:		1,680	US gallons		
Expected underflow solids concentratio		1 to	2 %wt		
Expected underflow (continuous):		7.7 to	15.5 USGPM		

Flashmixer:	vol. each:	140 gal	Retention time:	12.5 sec
	drive:	0.5 HP constant speed drive motor 230/460V / 3 ph / 60 Hz		
Flocculator:	vol. each:	900 gal	Retention time:	1.3 min
	drive:	0.5 HP variable speed drive 230/460V / 3 ph / 60 Hz		

LGS unit designed for Seismic Zone: 4

In order to prove performance, lab testing of representative sample may be required.

SCOPE:
Epoxy Coated Carbon Steel Tank
EPCS Flashmixer/Flocculator Tank
Ortho FRP Settling Plates with PVC Stiffeners
304SS Hardware
Hydro/Leak Test
Holiday (Coating Continuity) Test
Platform, Ladder, & Handrail are by others.

BUDGET PRICING: **$149,800** USD
FOB Point of Manufacture, freight allowed to jobsite, duty and brokerage included, taxes extra.
Start-Up visit including travel and travel expenses included.

SHIPMENT: 18 to 20 weeks after purchase.

PRICE VALIDITY: **30 DAYS**

Julio Moscoso
RM: John Deogracias
19-Oct-16
1401 W Cypress Creek Rd., Fort Lauderdale, FL 33309
tel: (954) 974-6610 fax: (954) 974-6182

Chromium 6 Removal – Centralized Treatment

California

Engineer
RMC Water

Represented by
Tom Roberson
MISCOwater
Foothill Ranch, California
949-458-5555
troberson@miscowater.com

Furnished by
Adrian Williams
awilliams@westech-inc.com

WesTech Opportunity Number: 1630457
Wednesday, October 26, 2016

Item A – Aluminum Induced Draft Aerator

We are proposing an Aluminum Induced Draft Aerator system for this project. This system is designed as follows:

Design Criteria	
Design Flow per Aerator	6,600 gpm
Number of Aerators	2
Size of Aerator	144 in square x 10 ft 0 in shell height
Hydraulic Loading Rate	22.9 gpm/ft^2
Blower Capacity	10,800 scfm
Air/Water Ratio	3.27 scfm/gpm
Blower Horsepower	1 ½ hp
Number of Blowers/unit	2

Technical Description:

Induced draft aeration is an effective, inexpensive and low-maintenance method of improving finished water quality in a large number of applications. Air is induced up through the aerator chamber, while water is introduced at the top of the unit, evenly distributed with a gravity tray, and free-falls through the aerator media. Upflowing air sweeps through the falling water to increase the oxygen content. Dissolved solids such as iron are transformed to their oxidized states, enabling them to be removed by downstream equipment. In addition, unwanted dissolved gases (e.g. carbon dioxide, hydrogen sulfide, VOC) are removed to reduce chemical requirements, stabilize pH, or eliminate objectionable tastes and odors.

Key Features and Benefits:

- Gravity inlet tray ensures uniform water distribution and air collection across internals while minimizing inlet pressure requirements, reduces pumping power costs compared to spray aerators.
- Aluminum construction eliminates painting and is corrosion resistant for simplified maintenance.
- Multiple internal media configurations optimize treatment performance.

The following budget pricing includes:

Square aluminum aerator housing with hinged and bolted side with support legs. Screened air intake and exhaust. Inspection port below the internals. Flanged inlet connection and plain end effluent connection. Moisture separator. Aluminum distribution tray. Ten rows of round 1 1/4 inch PVC slats spaced on 6" vertical centers. Aluminum and stainless steel induction blower with TENV drive motor. Freight to the job site and startup service. Induced Draft Aerator Web Site

*This proposal has been reviewed and is approved for issue by **Sarah Willett** on October 26, 2016.*

WesTech

Item B – Ultrafiltration Membrane System

Overview Scope of Supply		
Description	**Unit**	**Dimension/Capacity**
Application	-	Municipal Drinking Water
WesTech System Model	-	UFT96B, VersaFilter™ Open-Platform System
Gross Influent Flow Rate	gpm	10,608 gpm Total
Net Treated Flow Rate	gpm	10,250 gpm Total
Design and Number of Trains	-	6 x 16.67%, (6) total trains
Approximate Dimensions	Per Train	36’-3” L x 5’-10” W x 12’-3” H
Number of Modules	Per Train	90 installed, 94 capacity

WesTech ultrafiltration/microfiltration (UF/MF) systems are skid-mounted and factory-tested for ease of installation, straightforward operation, and long-term reliability. Major equipment and valves are pre-configured for efficient and error-free commissioning. System controls are fully automated and coordinated with our in-house electrical and controls engineers. Membrane filtration technology will produce high purity treated water, even with variation in the feed source quality.

WesTech is a leader in innovative membrane filtration system technology, including VersaFilter™ open-platform systems, AltaPac™ packaged systems, retrofit engineering solutions, intelligent controls and performance analysis technology. In addition to UF/MF equipment, WesTech offers pre- and post-treatment equipment for an integrated, complete process with consolidated equipment support.

As a company, WesTech has more pretreatment equipment experience before UF/MF membranes than any manufacturer. Our team has provided more than 60 systems throughout North America. As a company, WesTech has more than 18,000 process equipment installations throughout the world. This significant experience translates into reliable, time-tested equipment.

Process Description

Described in this proposal is the preliminary process and design of the WesTech VersaFilter™ open-platform membrane filtration system for this project. The preliminary system design will provide pretreatment to the reverse osmosis system at a central water treatment facility and consists of six (6) membrane filtration trains sized to achieve a total net production capacity of 10,250 gpm. Each train has capacity for up to 94 modules, with 90 installed.

Feed water to the ultrafiltration membrane system is directly fed to the membrane system. VFD-controlled feed pumps (by others) direct the source water to a 200 µm pre-strainer for removal of larger debris. The feed pump controls will be configured to minimize flow variation between steps and instantaneous flux by operation of the maximum number of available units. The filtration process is an outside-in, pressure-driven process to remove suspended solids and turbidity, and to achieve 4-log reduction of pathogens like *Giardia* and *Cryptosporidium*. Ultrafiltration membranes can also achieve >1.5 log reduction of waterborne viruses.

Filtrate is sent to the storage tank (by others), which also serves as the backwash supply tank. Backwashing is by reversed inside/out flow at an interval of 20 - 60 minutes with air scour for increased agitation. A drain or filter-to-waste step is used to remove any additional accumulated material. Membrane integrity testing is conducted automatically once every 24 hours. The pressure decay test (PDT) is capable of detecting a single fiber break.

Maintenance cleans (MCs)/chemically-enhanced backwashes (CEBs) and clean-in-place (CIP) procedures are automated chemical cleaning processes used to recover membrane permeability. MCs/CEBs are typically performed with NaOCl once per day to once per week. The automated clean-in-place procedure is designed to occur no more frequently than once per month, is conducted with either NaOCl or acid, and is initiated when membrane permeability decreases to a specified value. Following chemical cleaning procedures, the membrane racks are drained by gravity to the suction of the membrane filtration rack drain pumps, and waste is subsequently sent to be neutralized and discharged. A rinse step and backwashing are used to remove residual chemical prior to resuming production. If desired, chemical cleaning waste can be captured and neutralized prior to discharge.

Design Information

Water Quality

Feed Water Quality*

Description	Unit	Concentration
Source	-	Well Water
pH		6.5 – 8.5
Temperature	°F	50 – 70
Turbidity	NTU	<10 avg.
Total Suspended Solids	mg/L	<10 avg.
Total Organic Carbon	mg/L	<3 avg.
Iron	mg/L	<0.5
Manganese	mg/L	<0.5

*Values are assumed and should be verified.

Treated Water Quality

Description	Unit	Concentration
Turbidity	NTU	≤ 0.10 NTU 95% of the time with a maximum turbidity of 0.3 NTU
Total Suspended Solids	mg/L	< 1
Silt Density Index	-	≤ 3
Giardia Removal*	-	≥ 4 log (99.99%)
Cryptosporidium Removal*	-	≥ 4 log (99.99%)
Virus Removal*	-	≥ 1.0 log removal (90.00%)

* Challenge-testing certification is provided by independent evaluation through the California Department of Public Health and NSF/ANSI 419. Typical removal levels exceed the certification level and are often on the order of 6-log. Additionally, the UF membranes achieve 1.5 log removals of viruses, though virus removal certification is only recognized up to 1.0 log by CDPH for any membrane filter.

Membrane Complete Process Design Summary

UF Design Summary

Parameter	One Skid Off	All Skids Operating
Number of Skids in Operation	5	6
WesTech System Model	VersaFilter	VersaFilter
Installed Modules per Skid	90	90
Total Module Capacity per Skid	94	94
Membrane Area per Module	775 ft²	775 ft²
Membrane Area in Operation	348,750 ft²	418,500 ft²
Design Temperature	50.0 °F	50.0 °F
Flux at Design Temperature	39.5 gfd	39.5 gfd
Normalized Flux (20°C) at Design Temperature	51.7 gfd	51.7 gfd
Flow Rates		
Instantaneous Flow Rate	9,556.7 gpm	11,468.1 gpm
Average Gross Flow Rate	**8,839.7 gpm**	**10,607.6 gpm**
Average Net Filtrate	8,541.7 gpm	10,250.0 gpm
Backwash Flow Rate	2,102.7 gpm	2,102.7 gpm
Approx. Net Filtrate Production per Day	**12,299,960 gpd**	**14,759,960 gpd**
Backwash Waste Volume per Day	117,422 gpd	212,906 gpd
Influent Used for Rinsing/Draining per Day	251,796 gpd	302,155 gpd
Water Recovery	96.6%	96.6%
Estimated Maintenance Clean Frequency	Daily to Weekly	Daily to Weekly
Estimated Clean-In-Place Frequency	>30 days	>30 days

WesTech

Scope of Supply Information

Detailed Scope of Supply

Item	Quantity	Description	Brand (or equal)
Membrane Modules	90/skid	Hollow-fiber, outside-in PVDF ultrafiltration	Toray
Skid Frame	6	Powder-coated carbon steel	-
Feed Pumps	By Others	-	-
Backwash Pump	By Others	-	-
Prestrainer	6	200 micron, automatic backwashing	Forsta
Compressed Air System for Instrument Air	By Others	Compressor, receiver, oil filter, and dryer	-
Blowers	1	Regenerative	FPZ
Clean-In-Place System			
NaOCl Dosing Pump	1	For CIP and MC procedures	Prominent
Citric Acid Dosing Pump	1	For CIP and MC procedures	Prominent
CIP Tank	1	HDPE, cone-bottom	Chem-tainer
pH Sensor	1	-	GF Signet
Heater	3	-	Chromalox
Temperature Transmitter	1	-	GF Signet
Recirculation Pump	1	-	Goulds
Turbidimeter	1 common feed 1 filtrate/skid 7 total	Hach 1720E w/sc200 controller Hach 1720E w/sc200 controller	Hach Hach
Flow Meters	1/skid	Bi-directional magnetic flow meter with transmitter	Siemens
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika, Ashcroft
Valves / Actuators	-	Manual and automated valves	Bray
Piping	-	Schedule 80 PVC, HDPE	-
Electrical Controls	Included as described below		Allen Bradley

Electrical and Controls System

Parameter	Quantity	Value
Master PLC Panel with Touchscreen HMI	1 (Shared with RO)	Allen Bradley
UF Local Remote I/O Panels	1 per skid, 6 total	
UF CIP Panel	1	

Additional Service and Equipment

On-site Technical Assistance and Training

WesTech has included on-site technical assistance during construction, pre-commissioning and start-up to ensure the equipment is installed and commissioned per WesTech and sub-suppliers requirements. All service visits will be completed by certified field technicians that are qualified and have experience working with WesTech MF/UF equipment.
Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

WesTech On-Site Service

Service	Number of Trips	Number of Days
Installation Assistance, Start-Up, Operator Training	3	15
Total Included Service	3	15

To supplement the above noted technical assistance, WesTech will provide 24 hour on-call emergency support for this project, as well as direct phone numbers to reach qualified and involved personnel on the project.

Comments and Clarifications

Shipment: Estimated shipment time is **16 to 18 weeks** after approved submittal drawings are received in our office.

Items not by WesTech

Electrical wiring, conduit, or electrical equipment, VFDs, MCC, feed and filtrate tanks, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

*This proposal has been reviewed and is approved for issue by **Jason Frazier** on October 26, 2016.*

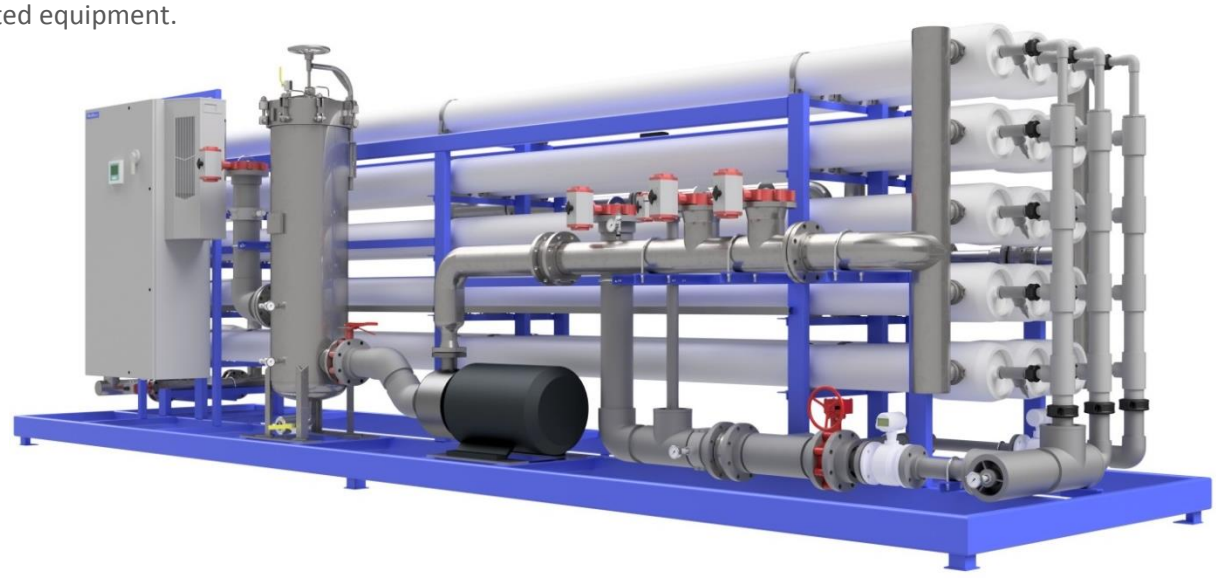
Item C – Reverse Osmosis Membrane System

Overview Scope of Supply		
Description	**Unit**	**Dimension/Capacity**
Application	-	Municipal Drinking Water
WesTech System Model	-	ROT94B
Membrane Element	-	Toray TMG20D-400
Gross Influent Flow Rate	gpm	8,750 gpm Total
Net Permeate Flow Rate	gpm	6,600 gpm Total
Anticipated Recovery	%	80
Design and Number of Trains	-	4 x 25%, (4) total trains
Approximate Dimensions	Per Train	26’-7” L x 10’-10” W x 13’-6” H

Benefits and Features

WesTech reverse osmosis (RO) systems are designed for ease of installation, straightforward operation, and long-term reliability. The proposed design is provided as skid-mounted, factory-tested units to minimize field assembly. Major equipment and valves are pre-configured for efficient and error-free commissioning. System controls are fully automated and coordinated with our in-house electrical and controls engineers, including a clean-in-place skid for automated cleaning.

WesTech is a leader in innovative membrane filtration system technology, including retrofit engineering solutions and intelligent controls. In addition to membrane filtration equipment, WesTech offers pre- and post-treatment equipment for an integrated, complete process with consolidated support. Our membrane filtration team has designed systems since 2002 with more than 60 systems throughout North America. As a company, WesTech has more than 40 years of experience and over 18,000 process equipment installations throughout the world. This significant experience translates into reliable, time-tested equipment.



Design Information

Water Quality

Reverse osmosis technology uses semi-permeable membranes for removal of dissolved contaminants, such as TDS, chlorides, and hardness from water. The basic principle of RO involves application of high pressure to counteract natural osmotic pressure to drive water from a more concentrated, feed solution to a pure water permeate. Dissolved impurities are removed during this process.

The following water quality information used as the system basis of design. Source water will be fed to the RO system from a break tank and feed pumps, which are assumed to be by others.

Projected Water Quality Streams

Description	Unit	RO Feed	Concentrate	Permeate*	Product*
Temperature	°F	70	70	70	70
pH	-	7.70	8.19	5.91	7.12
TDS	mg/L	1,042	5,112	23.21	260.2
SDI	mg/L	<3	-	-	-
Turbidity	mg/L	<0.3	-	-	-

*Water quality may be improved or hampered by changes in the feed water quality and fluctuations in dissolved constituent concentration and are not guaranteed values. Treated water quality from RO projections were based on 70°F at the end of 3 year element life, indicating expected minimum quality.

Process Design Summary

Four x 25% reverse osmosis trains will be used to treat municipal drinking water for Cr 6 removal. Each RO will treat a total feed water flow of 1,650 gpm for removal of TDS, sulfate, hardness, and chloride at a central water treatment facility. The design will produce 1,000 gpm of permeate, which be blended with a fee water bypass.

The following is a summary of the system design.

Process Design Summary and Operation

Parameter	Value
Operating Range	
Gross Feed Water Flow Rate	10,250 gpm total (2562.5 gpm/skid)
Feed Water Bypass Flow Rate	2,000 gpm total (500 gpm/skid)
Net Feed Flow Rate	8,250 gpm total (2,062.5 gpm/skid)
Permeate Flow Rate	6,600 gpm total (1,650 gpm/skid)
Blended Product Flow Rate	8,600 gpm total (2,150 gpm/skid)
Concentrate Flow Rate	1,650 gpm total (412.5 gpm/skid)
System Recovery	80%*
Average Flux Rate	15.70 gfd
Number of Trains	1 total 1 x 100% design
Array Configuration	36:18 7M; Two-Stage Design
Number of Pressure Vessels per Train	54
Number of Elements per Train	378
Membrane Element Diameter	8 in
Membrane Element Area	400 ft^2
Projected Feed Pressure	
-50°F	213.0 psi
-70°F	146.1 psi
Permeate Discharge Pressure	10 psig
Required System Feed Pressure	30 psig**

**Recovery can be improved or hampered based on fluctuations in feed water quality and antiscalant selected. At least 75% recovery is anticipated based on antiscalant feed.*

***30 psig feed pressure is required at the inlet of the RO skid, prior to the skid-mounted booster pump which increases the pressure to the required value.*

Scope of Supply Information

Detailed Scope of Supply

Item	Quantity	Description	Brand (or equal)
Membrane Elements	378/skid	8" Thin Film Composite (Polyamide)	Toray TMG20D-400
Skid Frame	4	Powder-coated carbon steel	-
Piping	-	Schedule 80 PVC low pressure 316 SS high pressure	-
Booster Pumps	1/skid	Centrifugal	Goulds
Cartridge Filters	1/skid	5 micron size	Filtrek
Element Housings	54/skid	8" FRP	Codeline
Clean-In-Place	1	*Separate skid*	
Recirculation Pump	1	For Chemical Recirculation	Goulds
Cartridge Filter Housing	1	5 micron size	Filtrek
CIP Tank	1	2000 gallons	-
Heater	1	18 kW	Chromalox
Conductivity Sensor	1/skid 1 shared	Permeate Feed	GF Signet
ORP Sensor	1 shared	Feed	GF Signet
Temperature Sensor	1 shared	Feed	GF Signet
Flowmeters	2/skid	Permeate and Concentrate	Siemens
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika, Ashcroft
Valves / Actuators	-	Manual and automated valves	Bray
Electrical Controls	Included as described below		Allen Bradley
Chemical Dosing Pump	4 total	Antiscalant Sodium Bisulfite	ProMinent
Feed Pumps	By Others	Single-Stage Centrifugal	-

Electrical and Controls System

Parameter	Quantity	Value
Master PLC Panel with Touchscreen HMI	1 (Shared with UF)	Allen Bradley
RO Local Remote I/O Panels	1 per skid, 4 total	
RO CIP Panel	1	

Additional Service and Equipment

On-site Technical Assistance and Training

WesTech has included on-site technical assistance during construction, pre-commissioning and start-up to ensure the equipment is installed and commissioned per WesTech and sub-suppliers requirements. All service visits will be completed by certified field technicians that are qualified and have experience working with WesTech membrane equipment.
Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

WesTech On-Site Service

Service	Number of Trips	Number of Days
Installation Assistance, Start-Up, Operator Training	3	15
Total Included Service	3	15

To supplement the above noted technical assistance, WesTech will provide 24 hour on-call emergency support for this project, as well as direct phone numbers to reach qualified and involved personnel on the project.

Clarifications

- Feed water temperature is anticipated to range from 50 to 70°F. Colder temperatures will increase operating pressure, while warmer temperatures will decrease water quality. Projections can be updated with confirmation of water temperature.

Items not by WesTech

Electrical wiring, conduit, or electrical equipment, VFDs, MCC, feed and permeate tanks, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

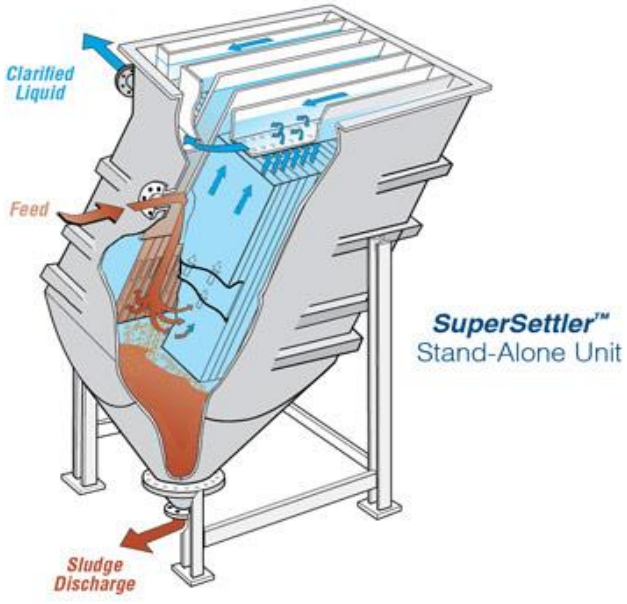
*This proposal has been reviewed and is approved for issue by **Jason Frazier** on October 26, 2016.*

Item D – Stand Alone SuperSettler™

General Scope of Supply		
Description	**Unit**	**Dimension/Capacity**
Application		Filter Backwash
Number of Units	each	1
Total Flow Rate	gpm	330
Flow Rate per Unit	gpm	330
Plate Surface Area per Unit	ft^2	1,076
Plate Efficiency	%	100
Plate Spacing	in	2
Inclined Plate Angle	deg	55
Total Effective Plate Surface Area	ft^2	1,076
Projected Loading Rate	gpm/ft^2	0.31
Flocculation Tank Volume	gal	18,300

Equipment Description

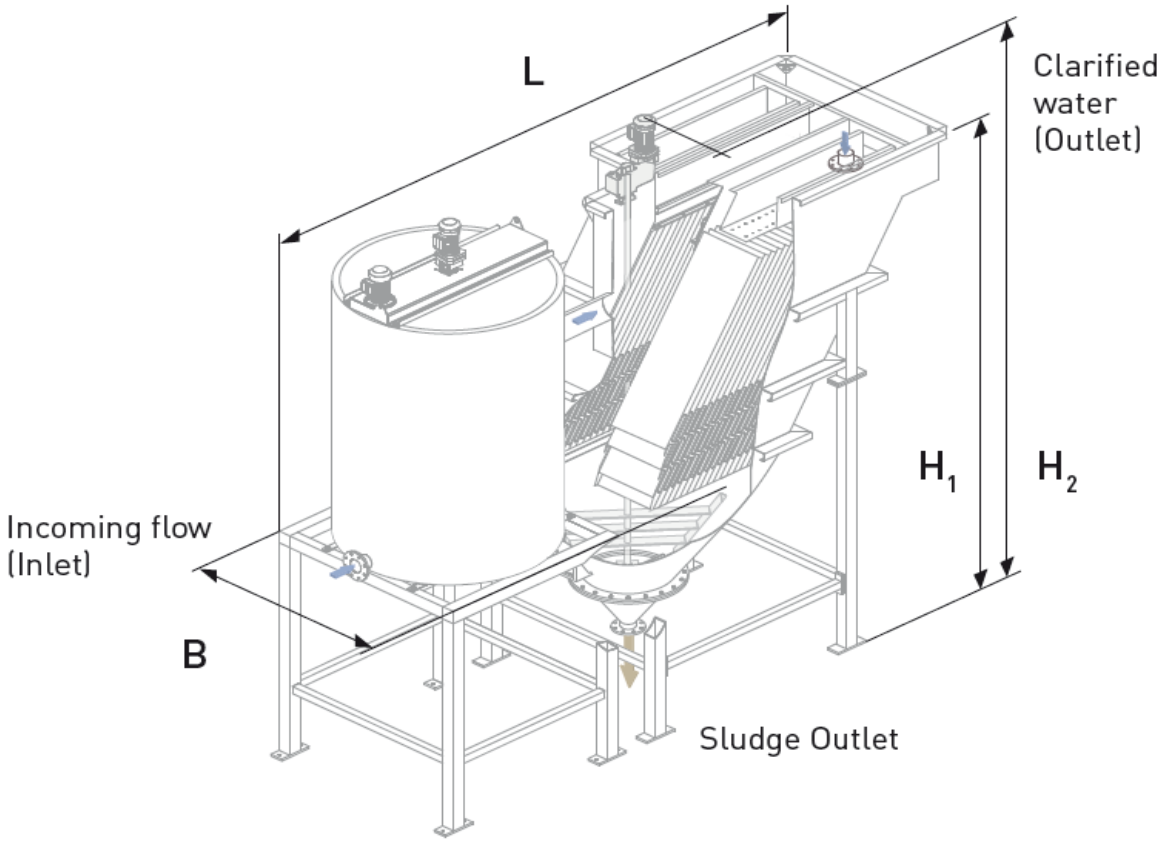
WesTech's SuperSettler Stand-alone units are designed as complete package units for smaller flow rates. The inclined plates are installed in stainless steel tanks with either a hopper or a sludge thickening bottom.



The SuperSettler's compact footprint is up to 1/10th the size of a conventional sedimentation basin.

Super Settler™ Dimensional Information

Description	Symbol	Unit	Dimension
Overall Length	L	Feet, inches	43'-11'
Tank Height	H_1	Feet, inches	26'-11"
Overall Height	H_2	Feet, inches	30'-8"
Width	B	Feet, inches	16'-4"



Detailed Scope of Supply

Item	Description	Material
Plate Settler Tank	Tank, support structure and baffles	304SS
Plates	Inclined plates	304SS
Sludge Hopper	Below plate housing for sludge collection. Hopper scraper shown in dimensioned drawing is not included with this proposal.	304SS
Launder	Two (2) effluent launders with submerged orifices	304SS
Flocculation Tank	Flocculation tank with internal rapid mix chamber	304SS
Interconnecting Piping	Piping between flocculation tank and plate settler tank	304SS
Assembly Fasteners		304SS

Drive Unit

Drive Unit

Description	Unit	Dimension/Capacity
Rapid Mix Drive	HP	1/4
Flocculator Drive	HP	1/2

Surface Preparation and Painting

Paint

Coating Area	Paint Type
Submerged Coating	Not Applicable - Stainless
Non-Submerged	Epoxy Paint
Drive Unit	Manufacturers standard enamel

Control Panel

Controls & Instrumentation

Description	Description	Notes
Housing	NEMA 4X 304SS	With painted steel back panel and mounting brackets
Local Switches	H/O/A, potentiometer	
Lights	Yes	
Emergency Stop	Yes	
Control Relays	Yes	
Timer	Sludge blowdown	
VFD	Included	With line reactor, control relays, terminal blocks, and other supporting hardware
Motor Starter	NEMA size 1	With internally reset thermal overloads

On-Site Service

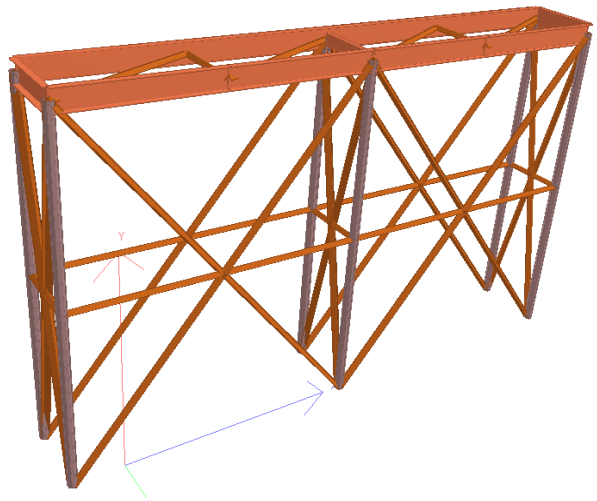
WesTech Trips to the Site

Number of Trips	Number of Days	Includes
Two (2)	Three (3)	Installation inspection, startup, and instruction of plant personnel

Equipment Options

Equipment Options

Item	Unit/Size	Quantity	Description	Material
Walkway			Walkway for access to the plate settler	HDG supports, Aluminum grating and handrail



Clarification Comments

All connecting piping, valves and controls other than those specified in this proposal BY OTHERS.

Note: Any Item Not Listed Above To Be Furnished By Others.

Items Not By WesTech

Electrical wiring, conduit or electrical equipment, piping, valves, or fittings, lubricating oil or grease, shop or field painting, field welding, erection, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, field service, (except as specifically noted).

*This proposal has been reviewed and is approved for issue by **Chelsea Stewardson** on October 26, 2016.*

Pricing

Proposal Name: Chromium 6 Removal – Centralized Treatment
Proposal Number: 1630457
Wednesday, October 26, 2016

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency		US Dollars
A	Aluminum Induced Draft Aerator	$150,000
B	UltraFiltration Membrane System	$2,820,000
C	Reverse Osmosis Membrane System	$2,650,000
D	Stand Alone SuperSettler™ Model PSS100	$220,000
D-1	Optional Walkway	$46,000
Field Service		US Dollars
Daily Rate		$960.00

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

Taxes (sales, use, VAT, IVA, IGV, duties, fees, import, etc.)	Not Included

3. Payment Terms

Submittal Approval	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

4. Schedule

Submittals, after PO receipt	6 to 8 weeks
Ready to Ship, after Submittal approval	18 to 20 weeks

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Freight: Prices quoted are **F.O.B. shipping point** with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

Chromium 6 Removal – Well Site Treatment

California

Engineer
RMC Water

Represented by
Tom Roberson
MISCOwater
Foothill Ranch, California
949-458-5555
troberson@miscowater.com

Furnished by
Adrian Williams
awilliams@westech-inc.com

WesTech Opportunity Number: 1630457
Wednesday, October 26, 2016

Item A – Aluminum Induced Draft Aerator

We are proposing an Aluminum Induced Draft Aerator system for this project. This system is designed as follows:

Design Criteria	
Design Flow per Aerator	500 gpm to 1,400 gpm
Number of Aerators	7
Size of Aerator	54 in square x 10 ft 0 in shell height to 96 in square x 10 ft 0 in shell height
Hydraulic Loading Rate	≤ 25 gpm/ft^2
Blower Capacity	1,519 scfm to 4,800 scfm
Air/Water Ratio	≤ 3 scfm/gpm
Blower Horsepower	½ hp or ¾ hp
Number of Blowers/unit	1

Technical Description:

Induced draft aeration is an effective, inexpensive and low-maintenance method of improving finished water quality in a large number of applications. Air is induced up through the aerator chamber, while water is introduced at the top of the unit, evenly distributed with a gravity tray, and free-falls through the aerator media. Upflowing air sweeps through the falling water to increase the oxygen content. Dissolved solids such as iron are transformed to their oxidized states, enabling them to be removed by downstream equipment. In addition, unwanted dissolved gases (e.g. carbon dioxide, hydrogen sulfide, VOC) are removed to reduce chemical requirements, stabilize pH, or eliminate objectionable tastes and odors.

Key Features and Benefits:

- Gravity inlet tray ensures uniform water distribution and air collection across internals while minimizing inlet pressure requirements, reduces pumping power costs compared to spray aerators.
- Aluminum construction eliminates painting and is corrosion resistant for simplified maintenance.
- Multiple internal media configurations optimize treatment performance.

The following budget pricing includes:

Square aluminum aerator housing with hinged and bolted side with support legs. Screened air intake and exhaust. Inspection port below the internals. Flanged inlet connection and plain end effluent connection. Moisture separator. Aluminum distribution tray. Ten rows of round 1 1/4 inch PVC slats spaced on 6" vertical centers. Aluminum and stainless steel induction blower with TENV drive motor. Freight to the job site and startup service.

Induced Draft Aerator Web Site

*This proposal has been reviewed and is approved for issue by **Sarah Willett** on October 26, 2016.*

WesTech

Item B – Ultrafiltration Membrane System

Overview Scope of Supply		
Description	**Unit**	**Dimension/Capacity**
Application	-	Municipal Drinking Water
WesTech System Model	-	UFT81B, VersaFilter™ Open-Platform System
Gross Influent Flow Rate	gpm	1,500 gpm Total
Net Treated Flow Rate	gpm	1,450 gpm Total
Design and Number of Trains	-	1 x 100%, (1) total trains
Approximate Dimensions	Per Train	33’-10” L x 5’-10” W x 12’-3” H
Number of Modules	Per Train	76 installed, 80 capacity

WesTech ultrafiltration/microfiltration (UF/MF) systems are skid-mounted and factory-tested for ease of installation, straightforward operation, and long-term reliability. Major equipment and valves are pre-configured for efficient and error-free commissioning. System controls are fully automated and coordinated with our in-house electrical and controls engineers. Membrane filtration technology will produce high purity treated water, even with variation in the feed source quality.

WesTech is a leader in innovative membrane filtration system technology, including VersaFilter™ open-platform systems, AltaPac™ packaged systems, retrofit engineering solutions, intelligent controls and performance analysis technology. In addition to UF/MF equipment, WesTech offers pre- and post-treatment equipment for an integrated, complete process with consolidated equipment support.

As a company, WesTech has more pretreatment equipment experience before UF/MF membranes than any manufacturer. Our team has provided more than 60 systems throughout North America. As a company, WesTech has more than 18,000 process equipment installations throughout the world. This significant experience translates into reliable, time-tested equipment.

Process Description

Described in this proposal is the preliminary process and design of the WesTech VersaFilter™ open-platform membrane filtration system for this project. The preliminary system design will provide pretreatment to the reverse osmosis system at each well site and consists of one (1) membrane filtration train sized to achieve an average net production capacity of 1,450 gpm. Each train has capacity for up to 80 modules, with 76 installed.

Feed water to the ultrafiltration membrane system is directly fed to the membrane system. VFD-controlled feed pumps (by others) direct the source water to a 200 µm pre-strainer for removal of larger debris. The feed pump controls will be configured to minimize flow variation between steps and instantaneous flux by operation of the maximum number of available units. The filtration process is an outside-in, pressure-driven process to remove suspended solids and turbidity, and to achieve 4-log reduction of pathogens like *Giardia* and *Cryptosporidium*. Ultrafiltration membranes can also achieve >1.5 log reduction of waterborne viruses.

Filtrate is sent to the storage tank (by others), which also serves as the backwash supply tank. Backwashing is by reversed inside/out flow at an interval of 20 - 60 minutes with air scour for increased agitation. A drain or filter-to-waste step is used to remove any additional accumulated material. Membrane integrity testing is conducted automatically once every 24 hours. The pressure decay test (PDT) is capable of detecting a single fiber break.

Maintenance cleans (MCs)/chemically-enhanced backwashes (CEBs) and clean-in-place (CIP) procedures are automated chemical cleaning processes used to recover membrane permeability. MCs/CEBs are typically performed with NaOCl once per day to once per week. The automated clean-in-place procedure is designed to occur no more frequently than once per month, is conducted with either NaOCl or acid, and is initiated when membrane permeability decreases to a specified value. Following chemical cleaning procedures, the membrane racks are drained by gravity to the suction of the membrane filtration rack drain pumps, and waste is subsequently sent to be neutralized and discharged. A rinse step and backwashing are used to remove residual chemical prior to resuming production. If desired, chemical cleaning waste can be captured and neutralized prior to discharge.

Design Information

Water Quality

Feed Water Quality*

Description	Unit	Concentration
Source	-	Well Water
pH		6.5 – 8.5
Temperature	°F	50 – 70
Turbidity	NTU	<10 avg.
Total Suspended Solids	mg/L	<10 avg.
Total Organic Carbon	mg/L	<3 avg.
Iron	mg/L	<0.5
Manganese	mg/L	<0.5

*Values are assumed and should be verified.

Treated Water Quality

Description	Unit	Concentration
Turbidity	NTU	≤ 0.10 NTU 95% of the time with a maximum turbidity of 0.3 NTU
Total Suspended Solids	mg/L	< 1
Silt Density Index	-	≤ 3
Giardia Removal*	-	≥ 4 log (99.99%)
Cryptosporidium Removal*	-	≥ 4 log (99.99%)
Virus Removal*	-	≥ 1.0 log removal (90.00%)

* Challenge-testing certification is provided by independent evaluation through the California Department of Public Health and NSF/ANSI 419. Typical removal levels exceed the certification level and are often on the order of 6-log. Additionally, the UF membranes achieve 1.5 log removals of viruses, though virus removal certification is only recognized up to 1.0 log by CDPH for any membrane filter.

Membrane Complete Process Design Summary

UF Design Summary

Parameter	One Skid Off	All Skids Operating
Number of Skids in Operation	N/A	1
WesTech System Model	N/A	VersaFilter
Installed Modules per Skid	N/A	76
Total Module Capacity per Skid	N/A	80
Membrane Area per Module	N/A	775 ft²
Membrane Area in Operation	N/A	58,900 ft²
Design Temperature	N/A	50.0 °F
Flux at Design Temperature	N/A	39.7 gfd
Normalized Flux (20°C) at Design Temperature	N/A	51.9 gfd
Flow Rates	N/A	
Instantaneous Flow Rate	N/A	1,622.2 gpm
Average Gross Flow Rate	N/A	**1,500.0 gpm**
Average Net Filtrate	N/A	1,450.0 gpm
Backwash Flow Rate	N/A	1,784.6 gpm
Approx. Net Filtrate Production per Day	N/A	**2,088,000 gpd**
Backwash Waste Volume per Day	N/A	30,116 gpd
Influent Used for Rinsing/Draining per Day	N/A	42,573 gpd
Water Recovery	N/A	96.6%
Estimated Maintenance Clean Frequency	N/A	Daily to Weekly
Estimated Clean-In-Place Frequency	N/A	>30 days

WESTECH

Scope of Supply Information

Detailed Scope of Supply

Item	Quantity	Description	Brand (or equal)
Membrane Modules	76/skid	Hollow-fiber, outside-in PVDF ultrafiltration	Toray
Skid Frame	1	Powder-coated carbon steel	-
Feed Pumps	By Others	-	-
Backwash Pump	By Others	-	-
Prestrainer	1	200 micron, automatic backwashing	Forsta
Compressed Air System for Instrument Air	By Others	Compressor, receiver, oil filter, and dryer	-
Blowers	1	Regenerative	FPZ
Clean-In-Place System			
NaOCl Dosing Pump	1	For CIP and MC procedures	Prominent
Citric Acid Dosing Pump	1	For CIP and MC procedures	Prominent
CIP Tank	1	HDPE, cone-bottom	Chem-tainer
pH Sensor	1	-	GF Signet
Heater	3	-	Chromalox
Temperature Transmitter	1	-	GF Signet
Recirculation Pump	1	-	Goulds
Turbidimeter	1 common feed 1 filtrate/skid 2 total	Hach 1720E w/sc200 controller Hach 1720E w/sc200 controller	Hach Hach
Flow Meters	1/skid	Bi-directional magnetic flow meter with transmitter	Siemens
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika, Ashcroft
Valves / Actuators	-	Manual and automated valves	Bray
Piping	-	Schedule 80 PVC, HDPE	-
Electrical Controls	Included as described below		Allen Bradley

Electrical and Controls System

Parameter	Quantity	Value
Master PLC Panel with Touchscreen HMI	1 (Shared with RO)	Allen Bradley
UF Local Remote I/O Panels	1 per skid, 1 total	
UF CIP Panel	1	

Additional Service and Equipment

On-site Technical Assistance and Training

WesTech has included on-site technical assistance during construction, pre-commissioning and start-up to ensure the equipment is installed and commissioned per WesTech and sub-suppliers requirements. All service visits will be completed by certified field technicians that are qualified and have experience working with WesTech MF/UF equipment.
Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

WesTech On-Site Service

Service	Number of Trips	Number of Days
Installation Assistance, Start-Up, Operator Training	3	10
Total Included Service	3	10

To supplement the above noted technical assistance, WesTech will provide 24 hour on-call emergency support for this project, as well as direct phone numbers to reach qualified and involved personnel on the project.

Comments and Clarifications

Shipment: Estimated shipment time is **16 to 18 weeks** after approved submittal drawings are received in our office.

Items not by WesTech

Electrical wiring, conduit, or electrical equipment, VFDs, MCC, feed and filtrate tanks, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

*This proposal has been reviewed and is approved for issue by **Jason Frazier** on October 26, 2016.*

Item C – Reverse Osmosis Membrane System

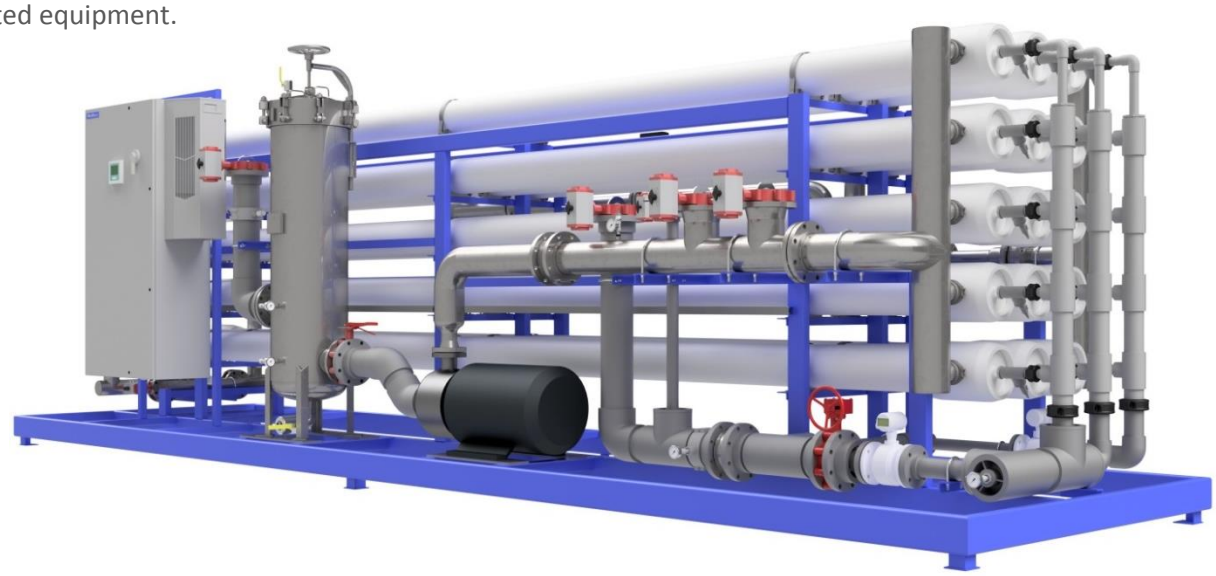
Overview Scope of Supply

Description	Unit	Dimension/Capacity
Application	-	Municipal Drinking Water
WesTech System Model	-	ROT81B
Membrane Element	-	Toray TMG20D-400
Gross Influent Flow Rate	gpm	1,250 gpm Total
Net Permeate Flow Rate	gpm	1,000 gpm Total
Anticipated Recovery	%	80
Design and Number of Trains	-	1 x 100%, (1) total trains
Approximate Dimensions	Per Train	26’-7” L x 10’-10” W x 9’-6” H

Benefits and Features

WesTech reverse osmosis (RO) systems are designed for ease of installation, straightforward operation, and long-term reliability. The proposed design is provided as skid-mounted, factory-tested units to minimize field assembly. Major equipment and valves are pre-configured for efficient and error-free commissioning. System controls are fully automated and coordinated with our in-house electrical and controls engineers, including a clean-in-place skid for automated cleaning.

WesTech is a leader in innovative membrane filtration system technology, including retrofit engineering solutions and intelligent controls. In addition to membrane filtration equipment, WesTech offers pre- and post-treatment equipment for an integrated, complete process with consolidated support. Our membrane filtration team has designed systems since 2002 with more than 60 systems throughout North America. As a company, WesTech has more than 40 years of experience and over 18,000 process equipment installations throughout the world. This significant experience translates into reliable, time-tested equipment.



Design Information

Water Quality

Reverse osmosis technology uses semi-permeable membranes for removal of dissolved contaminants, such as TDS, chlorides, and hardness from water. The basic principle of RO involves application of high pressure to counteract natural osmotic pressure to drive water from a more concentrated, feed solution to a pure water permeate. Dissolved impurities are removed during this process.

The following water quality information used as the system basis of design. Source water will be fed to the RO system from a break tank and feed pumps, which are assumed to be by others.

Projected Water Quality Streams

Description	Unit	RO Feed	Concentrate	Permeate*	Product*
Temperature	°F	70	70	70	70
pH	-	7.70	8.19	5.91	6.98
TDS	mg/L	1,042	5,112	23.36	193.2
SDI	mg/L	<3	-	-	-
Turbidity	mg/L	<0.3	-	-	-

*Water quality may be improved or hampered by changes in the feed water quality and fluctuations in dissolved constituent concentration and are not guaranteed values. Treated water quality from RO projections were based on 70°F at the end of 3 year element life, indicating expected minimum quality.

Process Design Summary

One x 100% reverse osmosis trains will be used to treat municipal drinking water for Cr 6 removal. Each RO will treat an average total feed water flow of 1,250 gpm for removal of TDS, sulfate, hardness, and chloride at each of the well sites. The design will produce 1,000 gpm of permeate, which be blended with a fee water bypass.

The following is a summary of the system design.

Process Design Summary and Operation

Parameter	Value
Operating Range	
Gross Feed Water Flow Rate	1,450 gpm total
Feed Water Bypass Flow Rate	200 gpm total
Net Feed Flow Rate	1,250 gpm total
Permeate Flow Rate	1,000 gpm total
Blended Product Flow Rate	1,200 gpm total
Concentrate Flow Rate	250 gpm total
System Recovery	80%*
Average Flux Rate	15.60 gfd
Number of Trains	1 total 1 x 100% design
Array Configuration	22:11 7M; Two-Stage Design
Number of Pressure Vessels per Train	33
Number of Elements per Train	231
Membrane Element Diameter	8 in
Membrane Element Area	400 ft^2
Projected Feed Pressure	
-50°F	211.3 psi
-70°F	145.1 psi
Permeate Discharge Pressure	10 psig
Required System Feed Pressure	30 psig**

**Recovery can be improved or hampered based on fluctuations in feed water quality and antiscalant selected. At least 75% recovery is anticipated based on antiscalant feed.*

***30 psig feed pressure is required at the inlet of the RO skid, prior to the skid-mounted booster pump which increases the pressure to the required value.*

Scope of Supply Information

Detailed Scope of Supply

Item	Quantity	Description	Brand (or equal)
Membrane Elements	231/skid	8" Thin Film Composite (Polyamide)	Toray TMG20D-400
Skid Frame	1	Powder-coated carbon steel	-
Piping	-	Schedule 80 PVC low pressure 316 SS high pressure	-
Booster Pumps	1/skid	Centrifugal	Goulds
Cartridge Filters	1/skid	5 micron size	Filtrek
Element Housings	33/skid	8" FRP	Codeline
Clean-In-Place	1	*Separate skid*	
Recirculation Pump	1	For Chemical Recirculation	Goulds
Cartridge Filter Housing	1	5 micron size	Filtrek
CIP Tank	1	2000 gallons	-
Heater	1	18 kW	Chromalox
Conductivity Sensor	1/skid 1 shared	Permeate Feed	GF Signet
ORP Sensor	1 shared	Feed	GF Signet
Temperature Sensor	1 shared	Feed	GF Signet
Flowmeters	2/skid	Permeate and Concentrate	Siemens
Pressure Instrumentation	-	Transmitters, switches, gauges	Wika, Ashcroft
Valves / Actuators	-	Manual and automated valves	Bray
Electrical Controls	Included as described below		Allen Bradley
Chemical Dosing Pump	2 total	Antiscalant Sodium Bisulfite	ProMinent
Feed Pumps	By Others	Single-Stage Centrifugal	-

Electrical and Controls System

Parameter	Quantity	Value
Master PLC Panel with Touchscreen HMI	1 (Shared with UF)	Allen Bradley
RO Local Remote I/O Panels	1 per skid, 1 total	
RO CIP Panel	1	

Additional Service and Equipment

On-site Technical Assistance and Training

WesTech has included on-site technical assistance during construction, pre-commissioning and start-up to ensure the equipment is installed and commissioned per WesTech and sub-suppliers requirements. All service visits will be completed by certified field technicians that are qualified and have experience working with WesTech membrane equipment.
Any additional trips that the customer may request can be purchased at the standard WesTech daily rates plus travel and living expenses.

WesTech On-Site Service

Service	Number of Trips	Number of Days
Installation Assistance, Start-Up, Operator Training	3	10
Total Included Service	3	10

To supplement the above noted technical assistance, WesTech will provide 24 hour on-call emergency support for this project, as well as direct phone numbers to reach qualified and involved personnel on the project.

Clarifications

- Feed water temperature is anticipated to range from 50 to 70°F. Colder temperatures will increase operating pressure, while warmer temperatures will decrease water quality. Projections can be updated with confirmation of water temperature.

Items not by WesTech

Electrical wiring, conduit, or electrical equipment, VFDs, MCC, feed and permeate tanks, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

*This proposal has been reviewed and is approved for issue by **Jason Frazier** on October 26, 2016.*

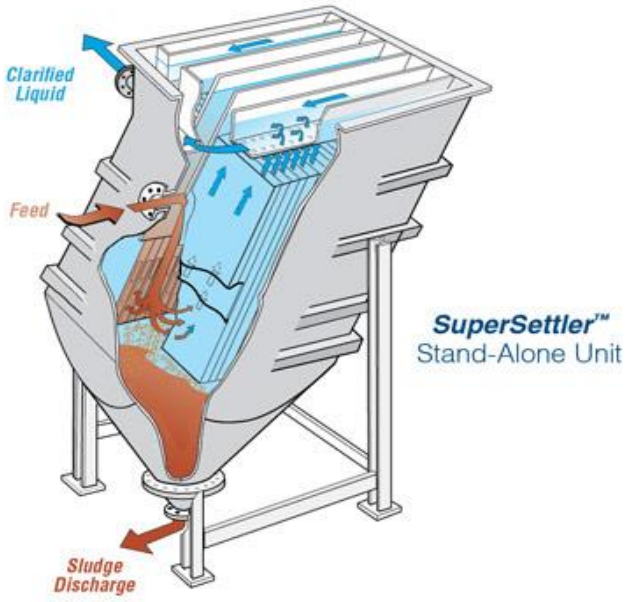
Item D – Stand Alone SuperSettler™

General Scope of Supply

Description	Unit	Dimension/Capacity
Application		Filter Backwash
Number of Units	each	1
Total Flow Rate	gpm	50
Flow Rate per Unit	gpm	50
Plate Surface Area per Unit	ft^2	161
Plate Efficiency	%	100
Plate Spacing	in	2
Inclined Plate Angle	deg	55
Total Effective Plate Surface Area	ft^2	161
Projected Loading Rate	gpm/ft^2	0.31
Flocculation Tank Volume	gal	530

Equipment Description

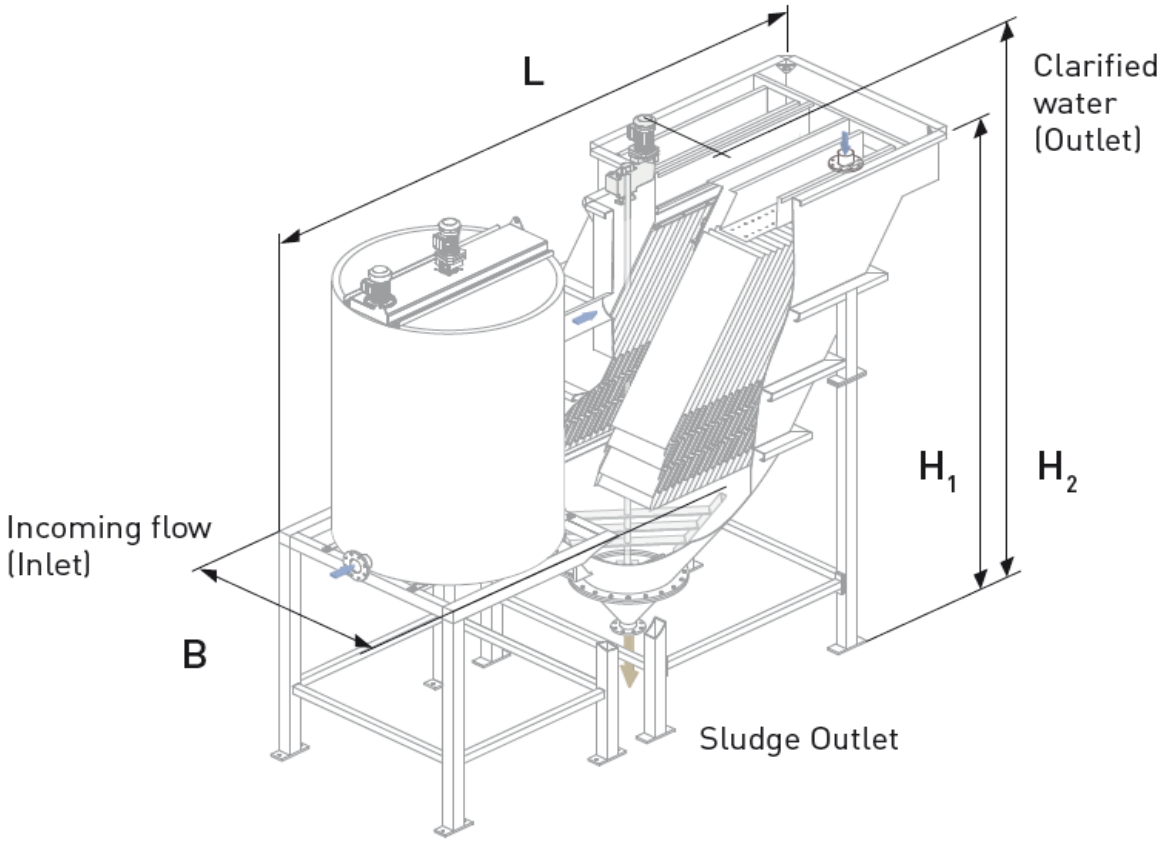
WesTech's SuperSettler Stand-alone units are designed as complete package units for smaller flow rates. The inclined plates are installed in stainless steel tanks with either a hopper or a sludge thickening bottom.



The SuperSettler's compact footprint is up to 1/10th the size of a conventional sedimentation basin.

Super Settler™ Dimensional Information

Description	Symbol	Unit	Dimension
Overall Length	L	Feet, inches	13'-3''
Tank Height	H_1	Feet, inches	10'-5''
Overall Height	H_2	Feet, inches	12'-6''
Width	B	Feet, inches	4'-7''



Detailed Scope of Supply

Item	Description	Material
Plate Settler Tank	Tank, support structure and baffles	304SS
Plates	Inclined plates	304SS
Sludge Hopper	Below plate housing for sludge collection. Hopper scraper shown in dimensioned drawing is not included with this proposal.	304SS
Launder	Two (2) effluent launders with submerged orifices	304SS
Flocculation Tank	Flocculation tank with internal rapid mix chamber	304SS
Interconnecting Piping	Piping between flocculation tank and plate settler tank	304SS
Assembly Fasteners		304SS

Drive Unit

Drive Unit		
Description	**Unit**	**Dimension/Capacity**
Rapid Mix Drive	HP	1/4
Flocculator Drive	HP	1/2

Surface Preparation and Painting

Paint	
Coating Area	**Paint Type**
Submerged Coating	Not Applicable - Stainless
Non-Submerged	Epoxy Paint
Drive Unit	Manufacturers standard enamel

Control Panel

Controls & Instrumentation		
Description	**Description**	**Notes**
Housing	NEMA 4X 304SS	With painted steel back panel and mounting brackets
Local Switches	H/O/A, potentiometer	
Lights	Yes	
Emergency Stop	Yes	
Control Relays	Yes	
Timer	Sludge blowdown	
VFD	Included	With line reactor, control relays, terminal blocks, and other supporting hardware
Motor Starter	NEMA size 1	With internally reset thermal overloads

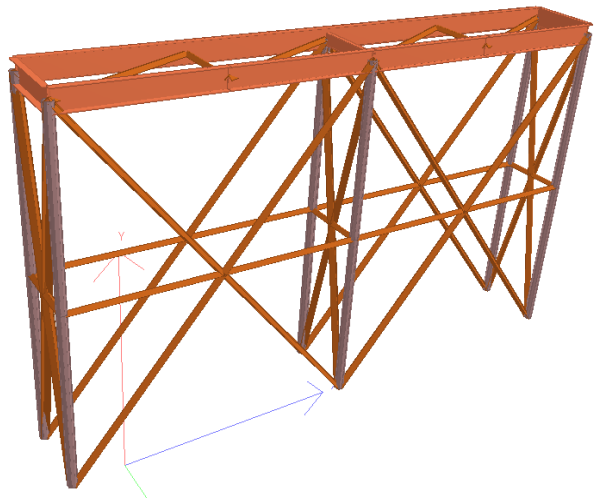
On-Site Service

WesTech Trips to the Site		
Number of Trips	**Number of Days**	**Includes**
Two (2)	Three (3)	Installation inspection, startup, and instruction of plant personnel

Equipment Options

Equipment Options

Item	Unit/Size	Quantity	Description	Material
Walkway			Walkway for access to the plate settler (see layout below)	HDG supports, Aluminum grating and handrail



Clarification Comments

All connecting piping, valves and controls other than those specified in this proposal BY OTHERS.

Note: Any Item Not Listed Above To Be Furnished By Others.

Items Not By WesTech

Electrical wiring, conduit or electrical equipment, piping, valves, or fittings, lubricating oil or grease, shop or field painting, field welding, erection, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, field service, (except as specifically noted).

*This proposal has been reviewed and is approved for issue by **Chelsea Stewardson** on October 26, 2016.*

Pricing

Proposal Name: Chromium 6 Removal – Well Site Treatment
Proposal Number: 1630457
Wednesday, October 26, 2016

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency		US Dollars
A	Aluminum Induced Draft Aerator	$280,000
B	UltraFiltration Membrane System	$600,000
C	Reverse Osmosis Membrane System	$740,000
D	Stand Alone SuperSettler™ Model PSS15	$116,000
D-1	Optional Walkway	$36,000
Field Service		US Dollars
Daily Rate		$960.00

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

Taxes (sales, use, VAT, IVA, IGV, duties, fees, import, etc.)	Not Included

3. Payment Terms

Submittal Approval	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

4. Schedule

Submittals, after PO receipt	6 to 8 weeks
Ready to Ship, after Submittal approval	18 to 20 weeks

WesTech

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Freight: Prices quoted are **F.O.B. shipping point** with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

Water.
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Solutions.

Corporate Headquarters

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PROJECT:

NORTHERN CALIFORNIA HEXAVALENT CHROMIUM REMOVAL

EQUIPMENT:

SBA ION EXCHANGE SYSTEMS

PREPARED FOR:

RMC WATER AND ENVIRONMENT

WWT BUDGET PROPOSAL No. 101316-200A

DATE: 10/13/16

Revision 0.0

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1.0 BASIS OF DESIGN

A summary of assumptions and operational design parameters used for calculating the operating costs for each site is shown below in Table 1. The corresponding waste volumes and operating costs are shown in Tables 2 and 3.

Table 1: Design Parameters used for Operational Cost Calculations

Parameter	**Value**
Regeneration Frequency	10,000 BV
Plant Utilization	50%
Brine/Regenerant Volume	3.5 BVs
Brine/Regenerant Recycled	1.5 BVs
Rinse Water (fast & slow rinse)	3 BVs (all recycled)
Waste Volume	2 BVs
Cr6 Leakage from IX Vessels	1.5 ppb
NaCl concentration	110 g/L
Resin Price	$135/ft3
Salt Cost	$90/ton ($0.045/lb)
Vessel Diameter - Well Sites	5 ft
Vessel Diameter – Central Facility	10 ft
Resin Depth per Vessel	36-37”
Operation & Sampling Labor per Site: Sampling, daily checks, optimization, log sheets: Filter Changes, Salt Deliveries & Waste Loading: Longer Term System Optimization/Shutdowns & Recommissioning:	 4 hrs/week (208 hours/year) Smaller System: 2 hours/month Larger System: 4 hours/month Smaller Systems (4 vessels): 24 hours/year Larger Systems (>4 vessels): 24 hours/year
Preventative and Corrective Maintenance Labor	Smaller System: 50 hours/year Larger System: 70 hours/year

Table 2: Summary of Vessel Sizing and Operating Parameters

Site	Design Flow	# Vessels	HLR - gpm/ft2		EBCT - min		Total Resin Volume	Max. Feed Cr6
	gpm	N	N	N-1	N	N-1	ft3	ppb
Well 1	1000	6	8.5	10.2	2.7	2.25	360	17
Well 2	500	4	6.4	8.5	3.6	2.7	240	21
Well 3	1400	9	7.9	8.9	2.9	2.6	540	38.1
Well 4	800	6	6.8	8.1	3.4	2.8	360	19
Well 5	700	6	5.9	7.1	3.0	3.2	360	26
Well 6	900	6	7.6	9.2	3.9	2.5	360	17
Well 7	1000	6	8.5	10.2	2.7	2.25	360	21
Central	5900	9 x 10ft dia	8.35	9.4	2.7	2.4	2124	21

Table 3: Summary of Waste Volumes and Operating Costs

Site	Annual Production	Regeneration Frequency	Waste/Regen/ All Vessels	Total Waste	Salt Use	Salt Cost
	MG	days	gal	gal/year	lb/year	$/year
Well 1	263	38	6,075	59,130	54,284	$2,443
Well 2	131	50	4,050	29,565	27,142	$1,221
Well 3	368	40	9,113	82,782	75,998	$3,420
Well 4	210	47	6,075	47,304	43,428	$1,954
Well 5	184	54	6,075	41,391	38,000	$1,710
Well 6	237	42	6,075	53,217	48,856	$2,200
Well 7	263	38	6,075	59,130	54,284	$2,443
Central	1550.5	38	35,850	348,900	320,278	$14,413

2.0 EQUIPMENT SCOPE OF SUPPLY

SBA ION EXCHANGE SYSTEMS EQUIPMENT DETAILS

Bag Filter Housing (Loose - Installed by Others)	
Quantity / Manufacturer	(2) Each capable of handling the full feed flow – sized for feed for each well.
Construction	304 Stainless, 6" Flange Connections, Swing Bolt Lid, 6 Round , #2 Bag Filters, 25 Micron, NSF 61
Notes	Pressure Gauges mounted on filter inlet and outlet to monitor pressure drop across the filters.
Well Sites: Triplex Anion Exchange Vessel Skids (3-4 vessels per skid)	
Skid Quantity	See Table 2 for each well site.
Tank Quantity and Type	(3) 60" Dia, 60" Side Shell, ASME Code rated for 120 PSI maximum working pressure. Epoxy coated carbon steel vessels.
Internal Piping (each tank)	Sch-80 PVC inlet/backwash collection consists of under drain system using headers and laterals made from Sch-80 PVC, supported by #304 SS clips on the tank side wall. Bottom dome of tank to be filled with supporting gravel.
Valve Nest (each tank)	Cement Mortar lined Ductile Iron Face piping includes the valves (manual & electric actuated butterfly), pressure gauges and sample valves for each vessel and backwash and Fast Rinse flow controllers. Each tank includes Crispin PL20-2" air release valves and pressure relief Valves.
Notes	All pressure vessels, piping, controls and instrumentation shall be skid mounted.
Ion Exchange Media	Purolite A600E 9149 anion exchange resin (60 cu.ft. per vessel). Ion exchange resin will be shipped separately for field installation by others with supervision by Wigen personnel.

Central Facility: Vessels Provided Loose with Face Piping Skids	
Tank Quantity and Type	(9) 120" Dia, 60" Side Shell, ASME Code rated for 120 PSI maximum working pressure. Epoxy coated carbon steel vessels.
Internal Piping (each tank)	Sch-80 PVC inlet/backwash collection consists of under drain system using headers and laterals made from Sch-80 PVC, supported by #304 SS clips on the tank side wall. Bottom dome of tank to be filled with supporting gravel.
Valve Nest (each tank)	Cement Mortar lined Ductile Iron Face piping includes the valves (manual & electric actuated butterfly), pressure gauges and sample valves for each vessel and backwash and Fast Rinse flow controllers. Each tank includes Crispin PL20-2" air release valves and pressure relief Valves.
Notes	All face piping piping, controls and instrumentation shall be skid mounted. Contractor will attach face piping skid to flanges on tanks.
Ion Exchange Media	Purolite A600E 9149 anion exchange resin (236 cu.ft. per vessel). Ion exchange resin will be shipped separately for field installation by others with supervision by Wigen personnel.

Ion Exchange Skid Controls/Electrical	
Processor (PLC)	Allen-Bradley Compactlogix, Ethernet programmable controller, housed in enclosure.
Operator Interface (HMI)	Allen-Bradley Panel View Plus 6, 10" color touch screen operator interface terminal. Mounted on internal panel inside enclosure to protect the HMI from the elements.
Enclosures	NEMA 4X, Stainless Steel
Location	Mounted on one of the skids.
Resin Traps	
Type	Cone Shaped 316 SS screen type, mounted between flanges on tank outlet and inlet piping.
Ion Exchange System Skid	
Quantity	(1)
Construction	Welded carbon steel channel, square tube & angle, with an industrial-grade powder coated finish

INSTRUMENTATION TABLE

Instrument	Location	Display	Manufacturer
Flow Meters	Each Tanks Outlet Piping, Blend flow, All Tanks Feed Flow	HMI/Local	ABB
Conductivity Meter	Waste Flow from Skid	HMI/Local	ThermoScientific
Pressure Gauges	Each Tank Inlet / Outlet	Local	Ashcroft

BRINE EQUIPMENT

Brine Maker (Loose - Installed by others)	
Size	10' dia x 15' high (top of dome), capable of storing 42 tons usable dry salt. (1) required for well sites and (2) for central facility.
Materials	NSF 61 certified FRP.
Brine Recycle Tank (Loose - Installed by Others)	
Size	1,000 gal, 78" Diameter (loose, to be installed by others)
Materials	Double Contained XLPE, Black
Water Reuse Tank (Loose - Installed by Others)	
Size	2,500 gal, 102" Diameter (loose, to be installed by others)
Materials	Double Contained XLPE, Black
Waste Tank (loose - Installed by Others)	
Size	8,700 gal, 141" Diameter (loose, to be installed by others)
Materials	Double Contained XLPE, Black
Brine Recycle / Brine Mix Transfer System (Mounted on Brine Mix Pump Skid)	
Brine Transfer Pumps	(2) Single phase, 1.0 HP, Mag drive pumps, flow meters included for Brine Mixing, manual valves used for flow control.
Reuse / Mix Pumps	(2) Three phase, 5.0 HP, SS pumps, VFD Drives, Flow meter included for brine mixing, slow rinse and reuse flow control.
Waste Pump	(2) Single phase, 1.0 HP, Mag drive pumps, Flow meters included for waste flow, manual valves used for flow control.
Control System	NEMA 4X Panel for controlling pumps, instrumentation, Regen and Reuse valves (I/O to be wired to PLC panel by others).
Skid Construction	Welded carbon steel channel & angle, with an industrial-grade powder coated finish.

Brine Mix / Recovery Water Softener Skid	
Softener Vessels	(2) 24" X 72" Softener Vessels, with 2900 Fleck Valves for Brine Generation and Brine Mix water treatment
Skid Construction	Welded carbon steel channel & angle, with an industrial-grade powder coated finish
Notes	Controlled by flow meter installed on outlet.
By-pass System	
Type	(1) Automatic control valve with controller to meet set flow for bypass, from 0 to 100% of plant flow (mounted on ion exchange vessel skid)

INSTRUMENTATION TABLE

Instrument	Location	Display	Manufacturer
Flow Meters	Brine Pump Outlet, Reuse Pump Outlet, Waste Pump Outlet	HMI/Local	Endress&Hauser
Tank Level Sensors	Brine tank Brine Level, Reuse Tank Level, Waste Tank Level (to be installed by others on site)	HMI/Local	Siemens

EXCLUSIONS

The following would be required **by others:**

- Disinfection dosing system will be supplied **by others.**
- Equipment installation will be **by others.**
- Header piping between vessels for Central Facility will be supplied **by others.**
- Loading of resin will be **by others.**
- Connections of inlet, outlet and drain piping to flanges on skids **by others**.
- 120 V Electrical drop to PLC control panel will be **by others.**
- Valves, piping, controls, wiring, fittings, etc. not contained within our skid boundaries or specifically outlined in the specification shall be provided **by others.**
- Cleaning and disinfection and of treatment facilities at startup will be **by others**.

MANUFACTURER'S START-UP SERVICES PER SITE

Trip	Service	No. days on site
1	Installation supervision	One trip, one (1) 8-hour day on site
2	Start up and operator training	Two trips, six (6) 8-hour days on site

3.0 BUDGET PRICING

The budget price for the SBA Ion Exchange equipment and startup services outlined above is as follows:

Site	Design Flow (gpm)	Budget Price
Well 1	1000	$800,000.00
Well 2	500	$600,000.00
Well 3	1400	$1,100,000.00
Well 4	800	$780,000.00
Well 5	700	$750,000.00
Well 6	900	$800,000.00
Well 7	1000	$800,000.00
Central	5900	$3,900,000.00

Budget Price is in US dollars FOB, Sacramento, CA exclusive of any applicable taxes.

Customer understands that this proposal has been issued based upon the information provided by customer, and currently available to WWT at the time of issuing this proposal. Any changes or discrepancies in site conditions, including but not limited to system influent water characteristics, changes in environmental health and safety conditions, Customer financial standing, Customer requirements, or any other relevant change, or discrepancy in, the factual basis upon which this proposal was created, may lead to changes in the offering, including but not limited to changes in pricing, warranties, quoted specifications, or terms and conditions.

Appendix B - Operational Yield Technical Memorandum

Technical Memorandum

City of Patterson Water Supply Master Plan

Subject:	**Operational Yield**
Prepared For:	Maria Encinas, City of Patterson
Prepared by:	Ian Jaffe, RMC Water and Environment Leslie Dumas, RMC Water and Environment
Reviewed by:	Enrique Lopezcalva, RMC Water and Environment
Date:	July 12, 2016
Reference:	0603-001.00

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1 Introduction

The City of Patterson (City) is updating their Water Master Plan. As part of this update, an Operational Yield Study (OYS) was conducted to determine an estimated volume of groundwater that the City could extract from the underlying Delta-Mendota Groundwater Basin without impacting their current groundwater pumping infrastructure and without significantly impacting the use of groundwater resources in the area surrounding the City's Sphere of Influence (SOI). An OYS was to provide the necessary, higher-level analysis of potential future groundwater yields without conducting a detailed, groundwater modeling study that would be required to estimate a safe yield from the groundwater basin as a whole. This approach is more practical and feasible than a Safe Yield Analysis given the available numerical groundwater models and data. Significant additional data and information would be required to conduct a Safe Yield Analysis, including estimates on the current and future groundwater pumping and intended use of other water users in the groundwater basin. The OYS provides the information required to make decisions on future reliance on groundwater as a supply for the City of Patterson.

2 Methodology

2.1 C2VSim

The OYS was conducted using the C2VSim numerical groundwater model for California's Central Valley. C2VSim is an integrated numerical model that simulates water movement through the linked land surface, groundwater and surface water flow systems in California's Central Valley. The model was developed for and is used by the California Department of Water Resource (DWR) for evaluating groundwater use, surface water-groundwater interactions, and surface water resources management in the Central Valley.

The C2VSIM model is based on the Central Valley Groundwater and Surface water Model (CVGSM), an integrated hydrologic model that was run with the Integrated Groundwater Surface water model (IGSM). The original CVGSM model was developed in 1990 and simulated the Central Valley hydrologic system from 1921 to 1980. DWR developed C2VSIM coarse grid model by converting CVGSM model to work with the Integrated Water Flow Model (IWFM). C2VSIM coarse grid model uses only 1,393 nodes and 1,392 elements and simulates the hydrological conditions of the Central Valley from 1921 to 2009.

The C2VSIM model is a highly parameterized integrated hydrologic model. Calibration of C2VSIM is primarily based on regional and local reported land use, water use, soil, and aquifer hydraulic and hydrologic parameters, such as crop ET, irrigation efficiency, soil hydrologic, streambed hydraulic, and aquifer hydrogeologic parameters. These parameters were adjusted during a robust calibration effort and involved the process of temporal and spatial calibration of the model to observed groundwater levels at 1,385 observation wells and observed streamflows at 26 streamflow gages (Department of Water Resources). Additional information regarding the C2VSim model can be found online.[1]

2.2 Modeling

Modeling scenarios evaluated using the C2VSim model evaluated three primary parameters: the volume of groundwater to be extracted in the future (and associated pumping schedule), the location of existing wells and potential future additional wells, and potential recurring droughts in the modeling hydrologic period. Additionally, baseline (current groundwater use) analyses were run to provide a point from which to evaluate each of the future scenarios. The overall goal of the OYS analysis was to identify the maximum volume of groundwater that the City could extract in the future, through buildout, without resulting in significant impacts (defined herein as drawdown) in aquifers above and below the Corcoran Clay layer outside the City's SOI. The following variables were combined to develop model scenarios in an iterative approach. Table 2-1 summarizes the different scenarios simulated in the model runs.

Pumping Volumes

Potential future pumping volumes were initially determined based on previous pumping data and demand projections. Baseline pumping volumes were set equal to 2012 pumping rates (4,200 acre-feet per year, AFY) which reflect water usage prior to major reductions in water use due to drought. RMC estimated future demand based on buildout land use and associated duty factors. This resulted in a demand of 14,600 AFY. Current plans and additional options being explored in the master plan include conservation and potable demand resulting from non-potable supplies so that a demand of roughly 12,000 AFY on groundwater from deep wells was selected as representative of buildout conditions. That demand was then roughly doubled (24,700 AFY) in order to set an upper limit and halved (6,000 AFY) in order to set a lower limit. Runs simulating this future maximum extraction rate (24,700 AFY) contain the number 1 in the

[1] http://baydeltaoffice.water.ca.gov/modeling/hydrology/C2VSim/index_C2VSIM.cfm

scenario name. Runs simulating the actual estimated demand (12,000 AFY) contained the number 2 in the scenario name. Model scenarios using the minimum volume of future groundwater extraction (6,000 AFY) include the number 3 in the scenario name. In order to determine the maximum volume of future groundwater extraction that could occur without significant drawdown outside the City's SOI, one additional pumping rate of 10,000 AFY (number 4) was also modeled. In all scenarios, buildout pumping volumes were reached using a step function (with five-year intervals) from existing pumping values to buildout projections.

Pumping Location

At present, the City's operating groundwater wells are all located in one general location on the east side of the city. As there are presently no specific locations planned for future wells, two possible options were evaluated – (a) expanding the existing well field by installing new wells in the same general location (and keeping production infrastructure generally consolidated), and (b) putting all future groundwater production wells at a second location on the northwest side of the City (in order to 'spread the impacts' of groundwater production). Under both options, it was assumed that all demands up to the current capacity (around 6,000 AFY) would be split among the existing wells and any demand above the current capacity would be pumped from the new wells. Additionally, it was assumed that all non-potable groundwater pumping was split between the existing non-potable wells and that no new non-potable wells would be installed.

Hydrology

Two different options were used for the hydrology settings of a model run. In one option, the default model hydrology was used. In the other case, the hydrology for a critical drought (from the historical years 1987 to 1992) were rerun at the end of the model run to represent an extreme scenario of high pumping rates (maximum groundwater demand) coinciding with low water availability. This is represented in Table 2-1 as "Shifted Critical Drought". In all cases, when the alternative future hydrology was used, it was assumed that all pumping (current and future) would be from wells located at the City's current well field on the eastern side of the City.

Table 2-1: Summary of Model Scenarios

Scenario	Buildout (2015) Pumping Volume (AFY)	No. of Well Fields Utilized	Model Hydrology
Base AB	4,200[a]	1	Default
Base C	4,200 [a]	1	Shifted Critical Drought
1A	24,700 [b]	1	Default
1B	24,700 [b]	2	Default
1C	24,700 [b]	1	Shifted Critical Drought
2A	12,000 [c]	1	Default
2B	12,000 [c]	2	Default
2C	12,000 [c]	1	Shifted Critical Drought
3A	6,000 [d]	1	Default
4A	10,000 [d]	1	Default

Notes:

a. Assumes pumping value remains constant at 2012 pumping rates (prior to reductions from the drought taking place).
b. Buildout volume from the 2010 Water Supply Analysis. Pumping rates utilized five-year steps to a projection in 2030 and then new step values from 2030 to the buildout value in 2050.
c. Buildout volumes from 2015 RMC demand analysis.
d. Buildout volume selected to try to determine the operational yield with minimal impacts outside City's SOI.

3 Modeling Results

Once the C2VSim modeling scenarios were completed, the results were processed and compared to the appropriate baseline results to assess the effects of future Patterson pumping on regional groundwater levels as well as potential impacts to the City's existing production wells. C2VSim produces groundwater elevation data for both above (layer 1) and below (layer 2) the Corcoran Clay. The Corcoran Clay layer is a regional aquitard that plays an important role in the hydrogeology of the region and effectively separates groundwater above it from that below it; as such, the depth of groundwater pumping may have a greater impact above or below the Corcoran Clay (depending on an individual well's screened depth).

3.1 Effect on Regional Groundwater Levels

In order to analyze the effects of projected future pumping on regional groundwater levels above and below the Corcoran Clay, the baseline scenario model results were subtracted from future pumping scenario results. The difference in groundwater levels at model run completion (December 2054) at each C2VSim node were then loaded into ArcGIS in order to create the drawdown contour figures presented in Appendix A.

The following observations can be made about the resulting groundwater level contours:

- The difference in the size (area) of the zone of influence between model runs of pumping from one or two well fields is not significant. This is likely due to the spacing of the wells relative to the size of the C2VSim elements.
- Repeating the 1987-1992 drought at the end of the model run (the highest demand period) does not appear to have a significant impact on the overall pumping impacts.
- The larger the buildout demand, the greater the difference in the drawdown between layer 1 and layer 2. Some of the City's wells are screened across the Corcoran Clay layer as it is represented in C2VSim; that is, the wells 'pump' from both layer 1 and layer 2 in the model. As pumping demands increase, the model appears to increase the contribution of flows from layer 1 to supplement the pumping from layer 2.
- A buildout pumping value of around 10,000 AFY (such as in Scenario 4a) appears to be a groundwater pumping rate the City can sustain while limiting the pumping zone of influence to the City's SOI.

Regional groundwater contours (above and below the Corcoran Clay) for each of the model runs can be found in Appendix A.

3.2 Effects on City's Existing Infrastructure

The second goal of the OYS was to determine the maximum pumping rate the City could sustain while not impacting the production rates of their existing wells (defined as not drawing down groundwater elevations below the well screens of existing production wells and therefore requiring the wells to be deepened). Drawdown and groundwater elevation hydrographs for each modeled scenario were prepared for each of the City's existing wells; the wells' current average groundwater elevations, and the elevations of the top and bottom of the well screens were also included on the plots. The hydrographs were then examined to determine if the water level would drop below the current operating thresholds and/or the well screens for the individual pumping parameters shown in Table 2-1.

As discussed in the previous section, simulating a buildout pumping value of around 10,000 AFY should limit the zone of influence to the City's SOI. As shown in Figure 3-1, the model run for buildout pumping of 10,000 AFY (Scenario 4A) shows that the groundwater level below the Corcoran Clay at Well #6 stays above or within the existing well screen for the duration of the simulation. Figure 3-2 shows that the groundwater level in Scenario 4A (10,000 AFY) drops about 10 feet by 2040. These figures are

representative of the hydrographs and drawdown plots for each well (found in Appendix B). Figure 3-3 summarizes the below-Corcoran drawdown at each of the well locations for all of the model runs.

Figure 3-1: Ground Water Level at Well #6 – Layer 2

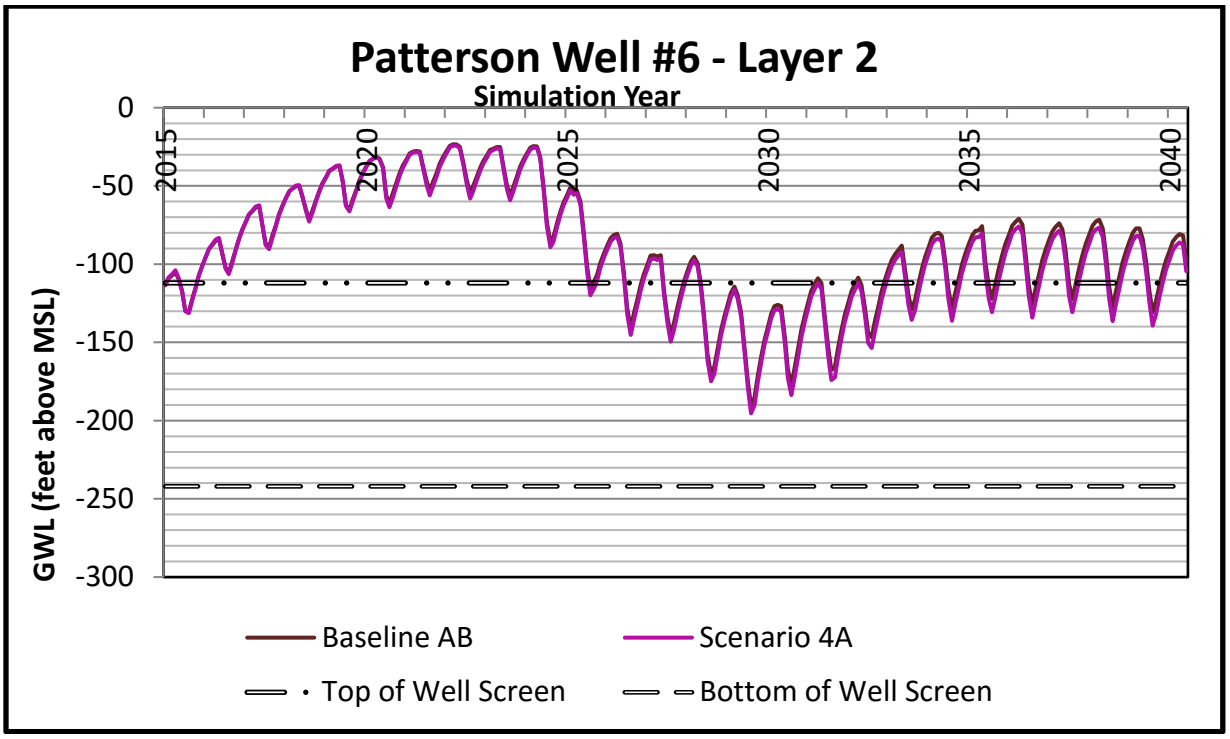


Figure 3-2: Groundwater Drawdown in Layer 2 at Well #6

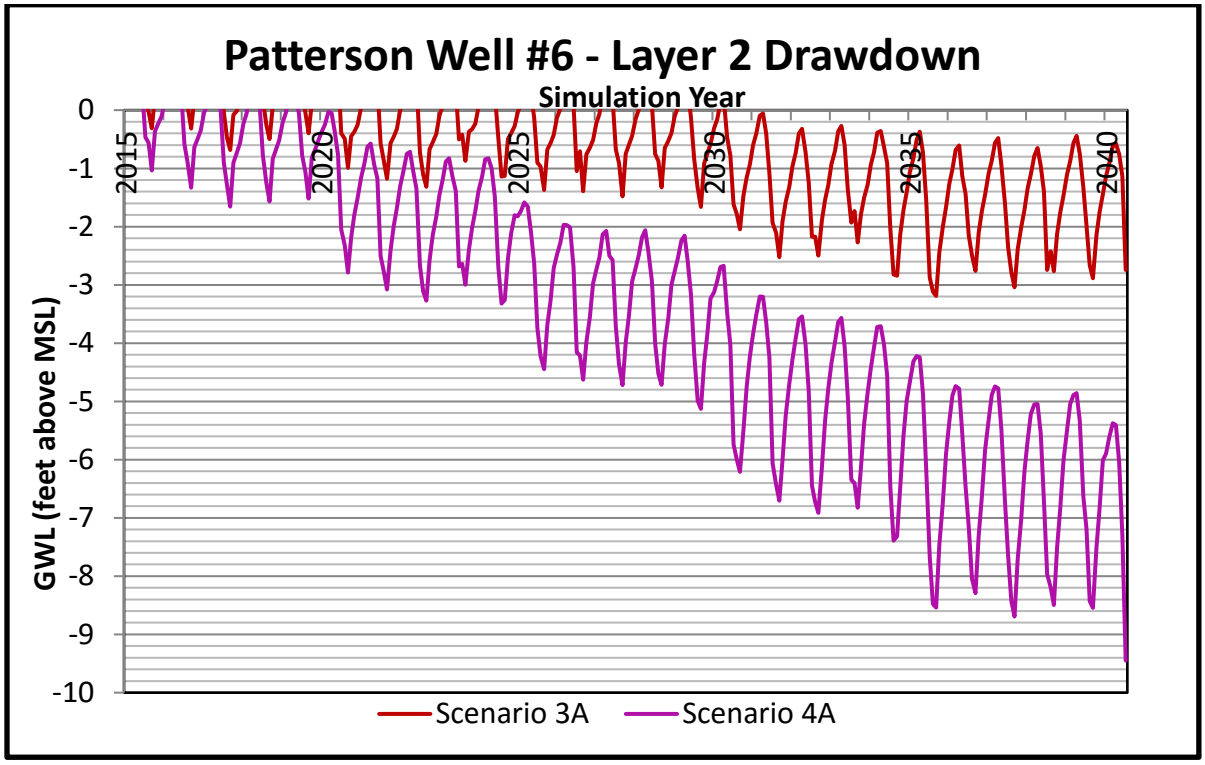
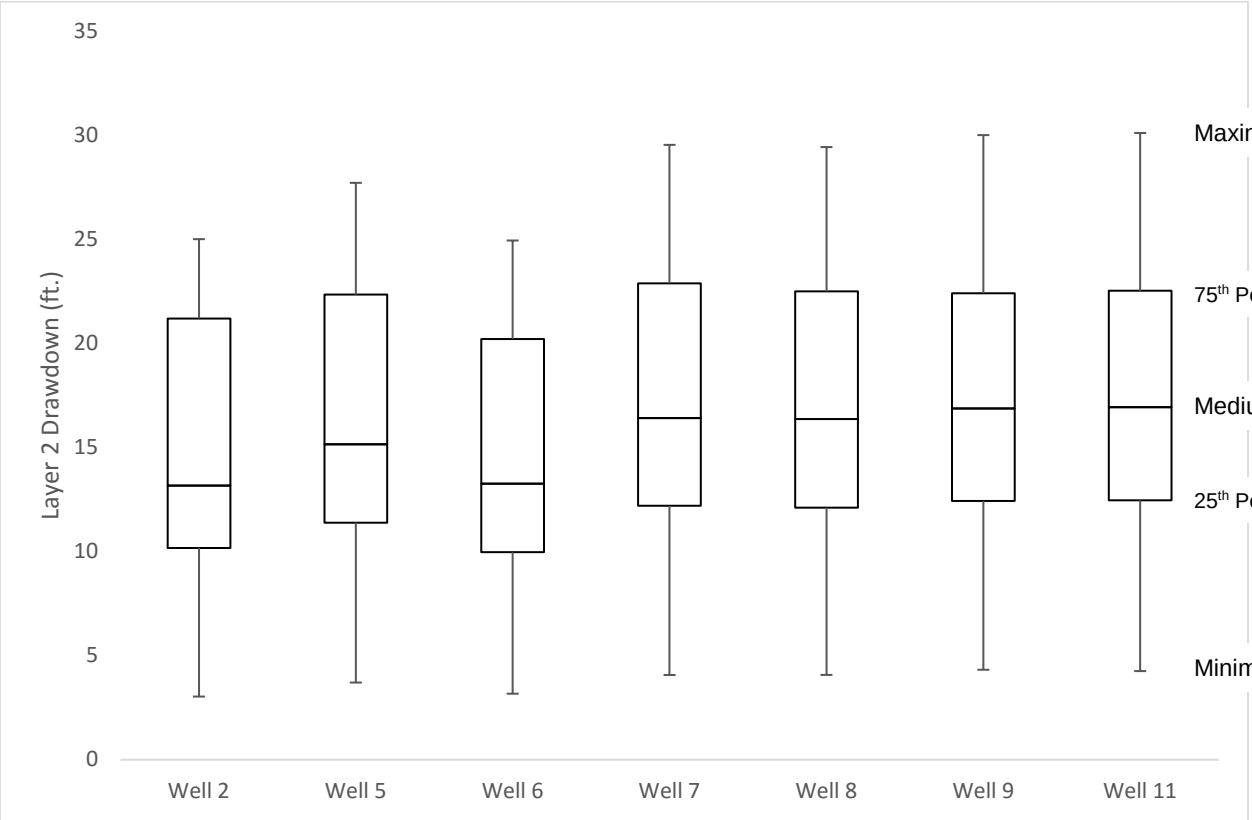


Figure 3-3: Summary of Layer 2 Drawdown at 2040



The following observations can be made about the groundwater hydrographs:

- There does not appear to be any significant impacts on the City's existing wells (evaluated as groundwater levels dropping below the well screen) in any of the model runs.
- The maximum drawdown in both layer 1 and layer 2 for any model run is around 32 feet.

Groundwater hydrographs at each of the existing wells (for both above and below the Corcoran Clay) can be found in Appendix B. These plots include the depth of the well screen for comparison to the drawdown.

4 Conclusions

In order to limit the zone of influence to the City's SOI, pumping should be limited to 10,000 AFY. At this future production rate, the production capacity of the City's current supply wells will not be impacted and the existing wells' screens are deep enough to accommodate the projected decreases in the groundwater elevations. Additionally, based on the model results, the City should plan to accommodate new pumping in areas of the city away from -not concentrated with- the current well field in order to minimize localizing (and therefore maximizing) pumping impacts.

5 Appendix A: Groundwater Contours

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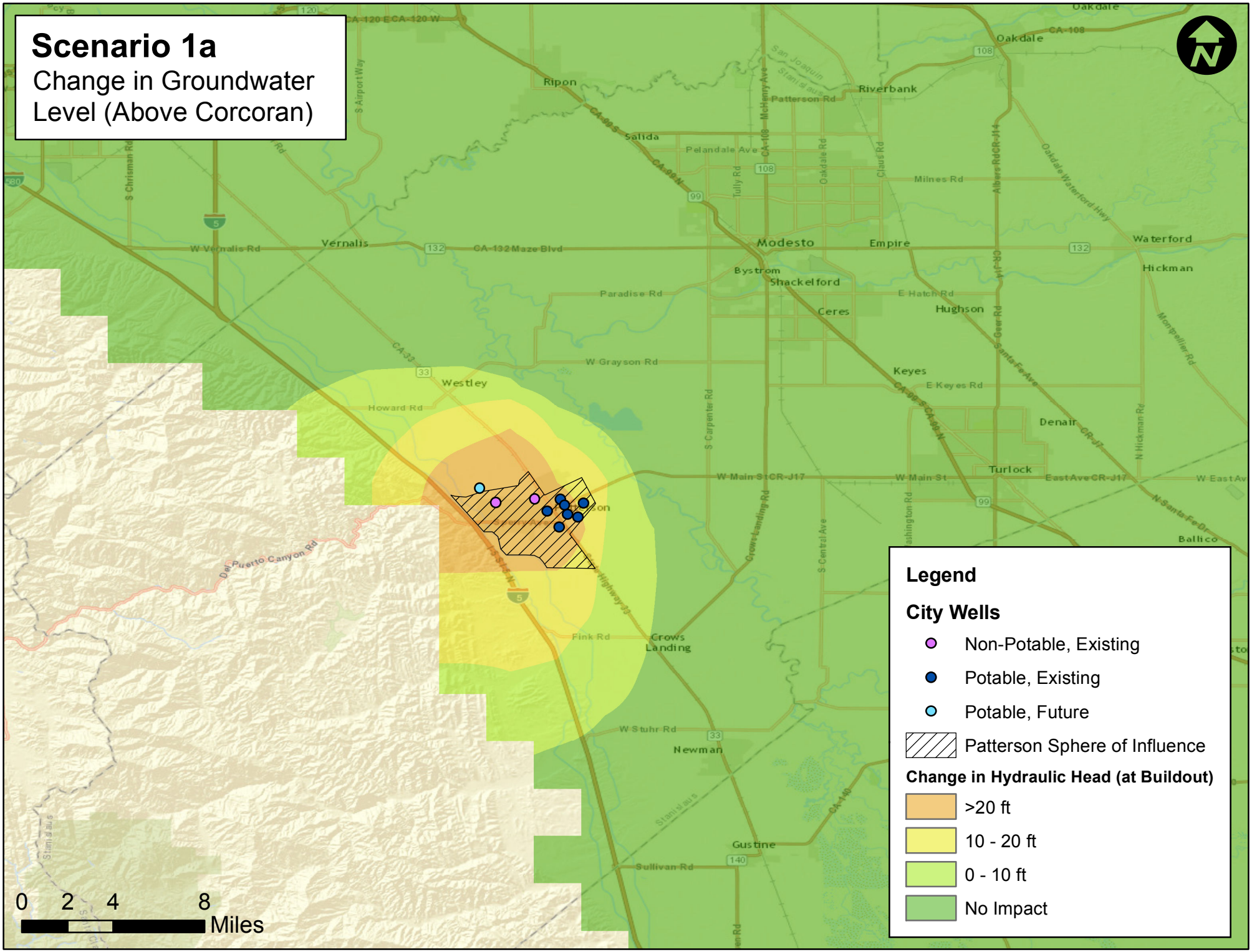
Scenario 1a
Change in Groundwater Level (Above Corcoran)
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
10 - 20 ft
0 - 10 ft
No Impact
0 2 4 8
Miles
Ripon
Salida
Riverbank
Oakdale
Modesto
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Waterford
Hickman
Bystrom
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Ceres
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Sullivan Rd
Del Puerto Canyon Rd
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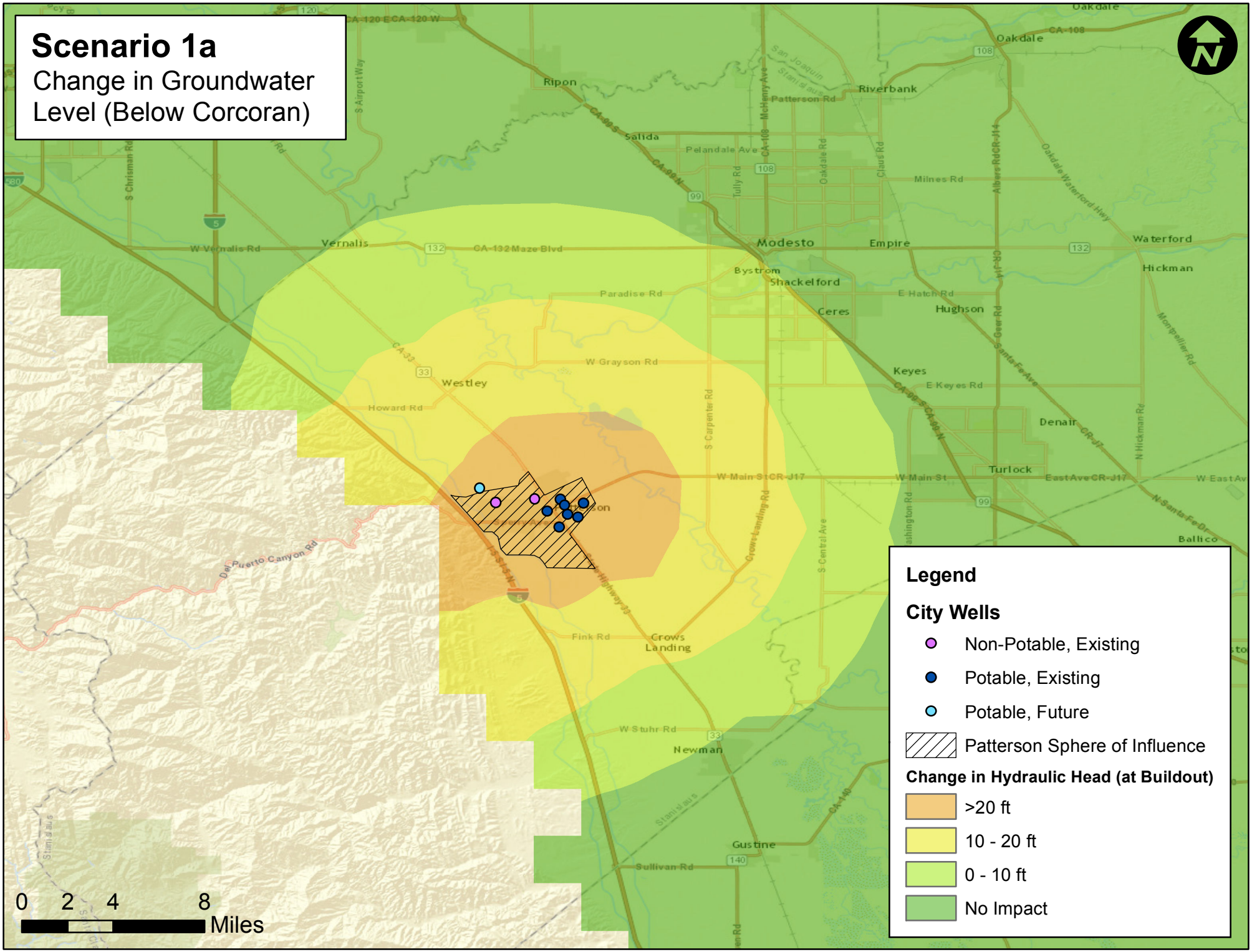
E Hatch Rd
Milnes Rd
Patterson Rd
W Vernalis Rd
CA-132 Maze Blvd
CA-120 E
CA-120 W
CA-99 S
CA-99 N
CA-33
CA-108
CA-140
Oakdale Waterford Hwy
Santa Fe Ave
S Carpenter Rd
S Central Ave
Crows Landing Rd
N Hickman Rd
Montpelier Rd
Claus Rd
Tully Rd
Oakdale Rd
Geer Rd
Albers Rd
McHenry Ave
S Airport Way
S Chrisman Rd
San Joaquin
Stanislaus
Del Puerto Canyon
Fink Road
Highway 33
CR-J14
CR-J17
W Main St CR-J17
East Ave CR-J17
W East Av
N Santa Fe Dr


Scenario 1a
Change in Groundwater Level (Below Corcoran)
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
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No Impact
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Montpelier Rd
Oakdale Waterford Hwy
N Santa Fe Dr
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CR-J7
S Airport Way
S Chrisman Rd
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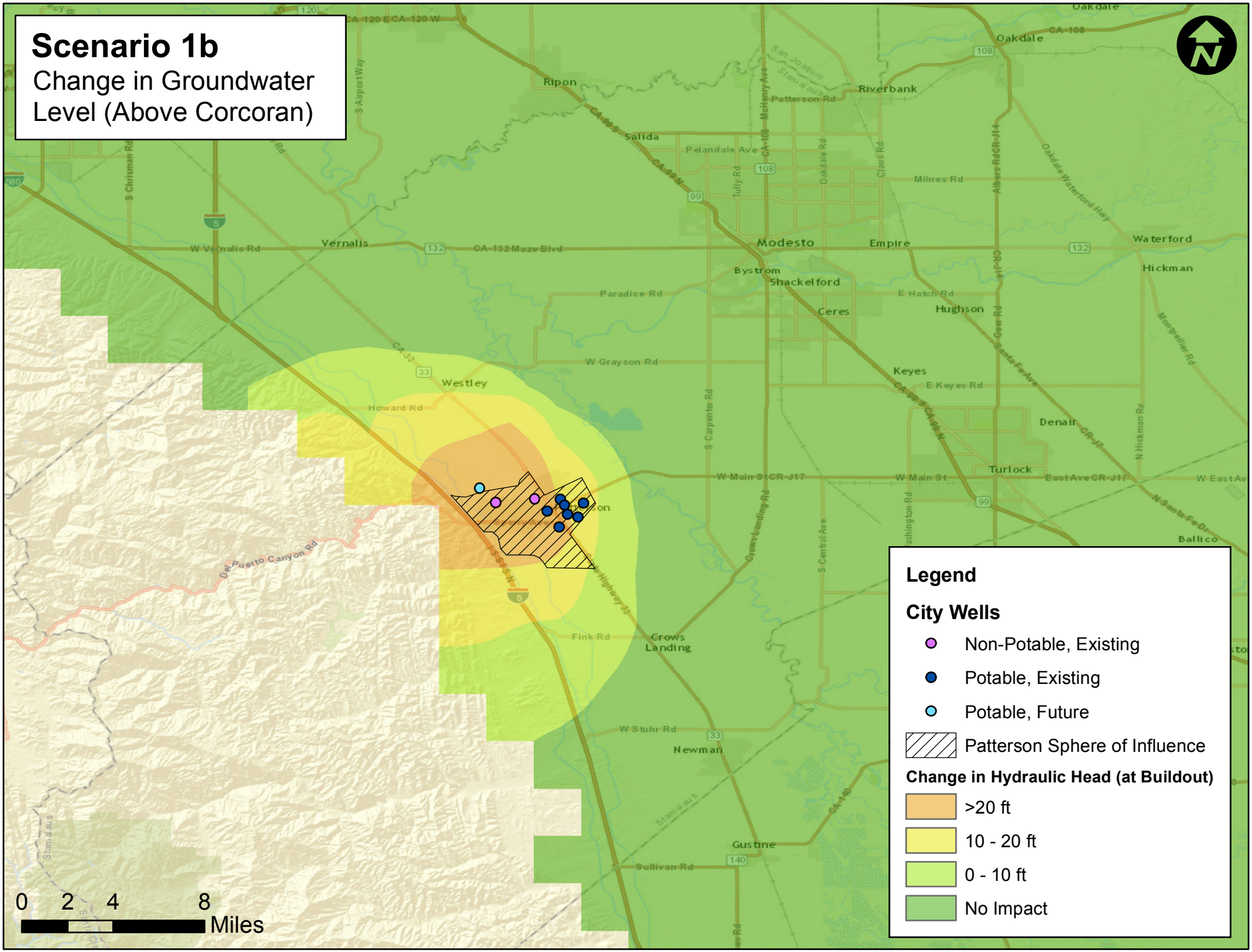
San Joaquin
McHenry Ave
Washington Rd


Scenario 1b
Change in Groundwater Level (Above Corcoran)
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City Wells
Non-Potable, Existing
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Potable, Future
Patterson Sphere of Influence
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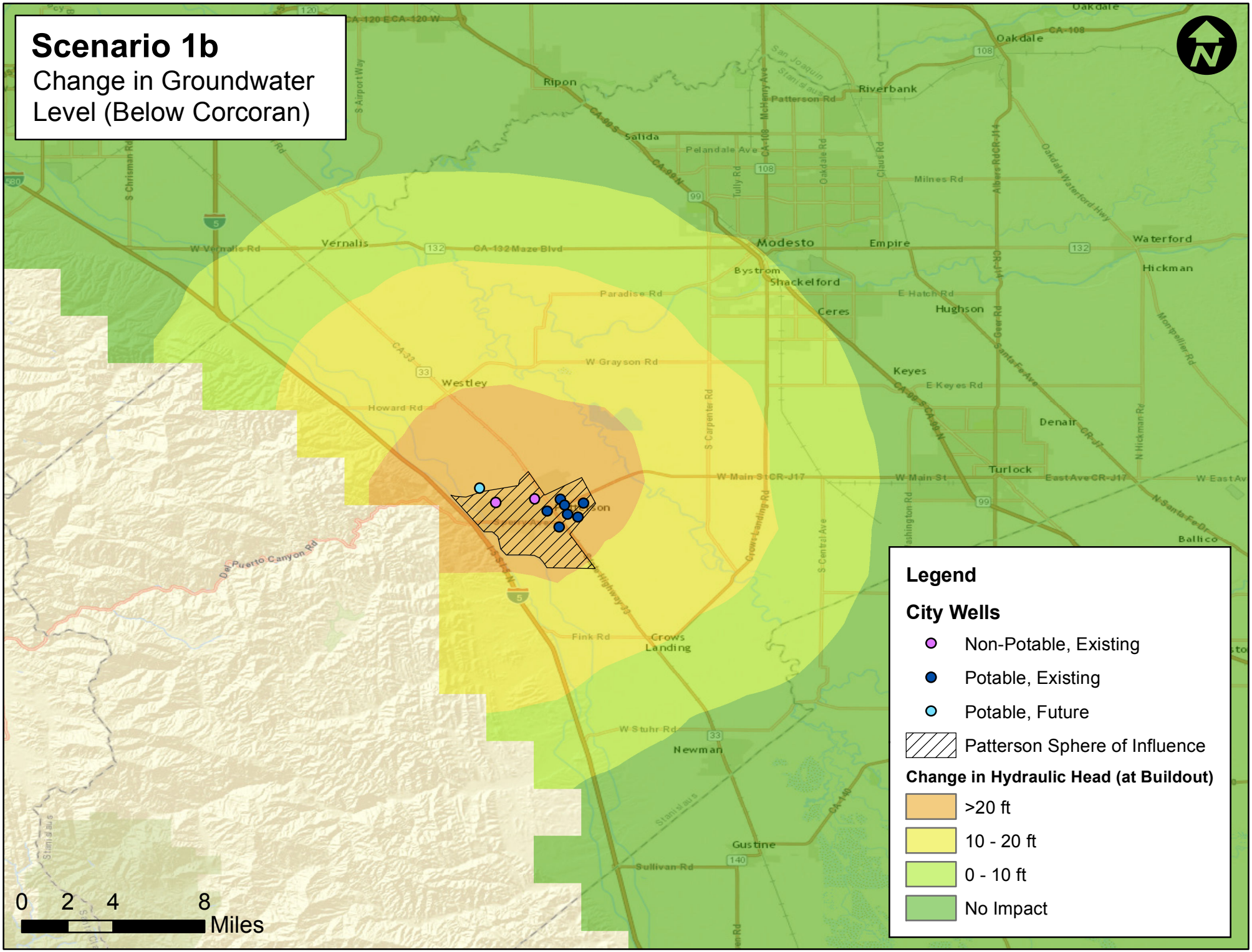
Scenario 1b
Change in Groundwater Level (Below Corcoran)
Legend
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Potable, Existing
Potable, Future
Patterson Sphere of Influence
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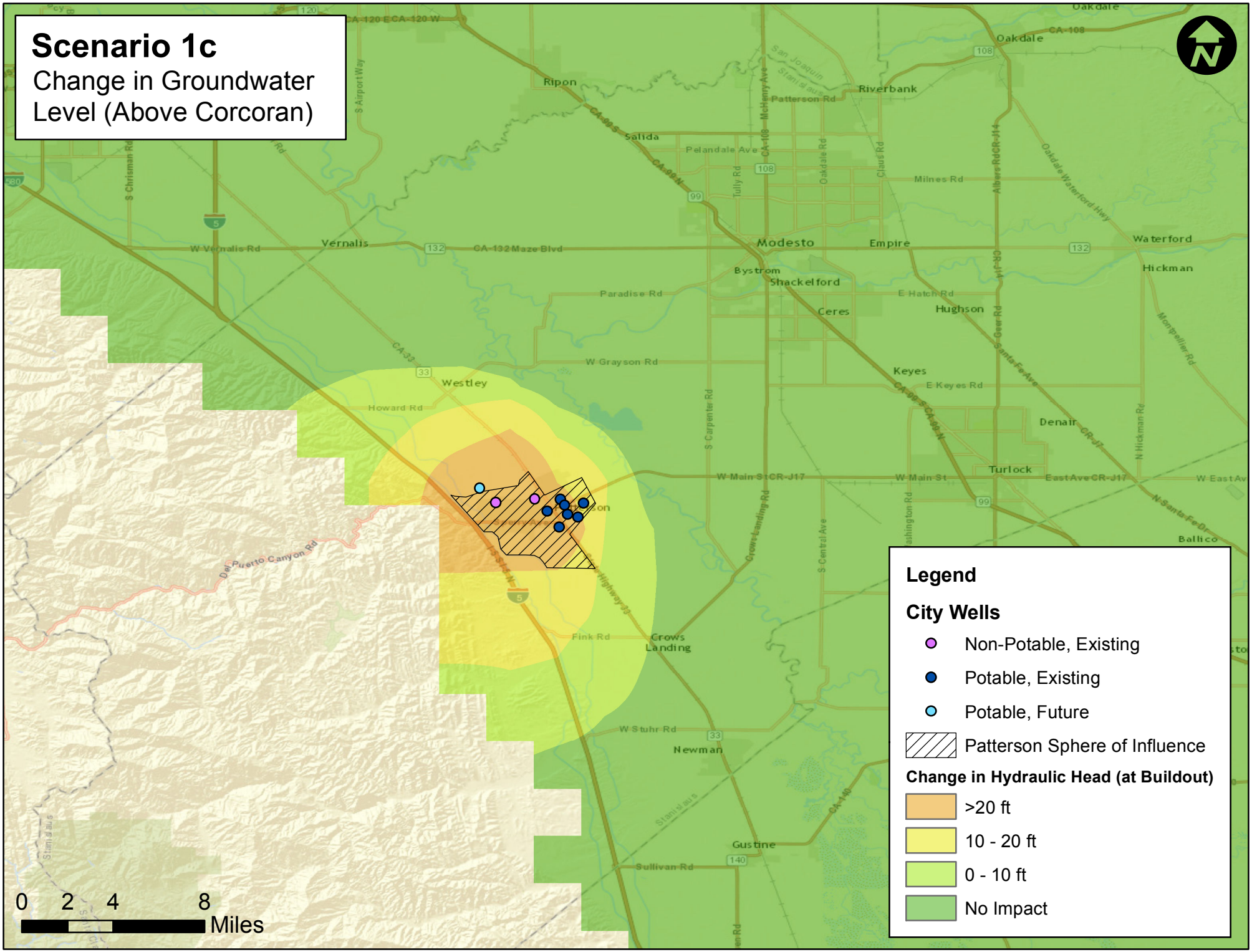
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Patterson Sphere of Influence
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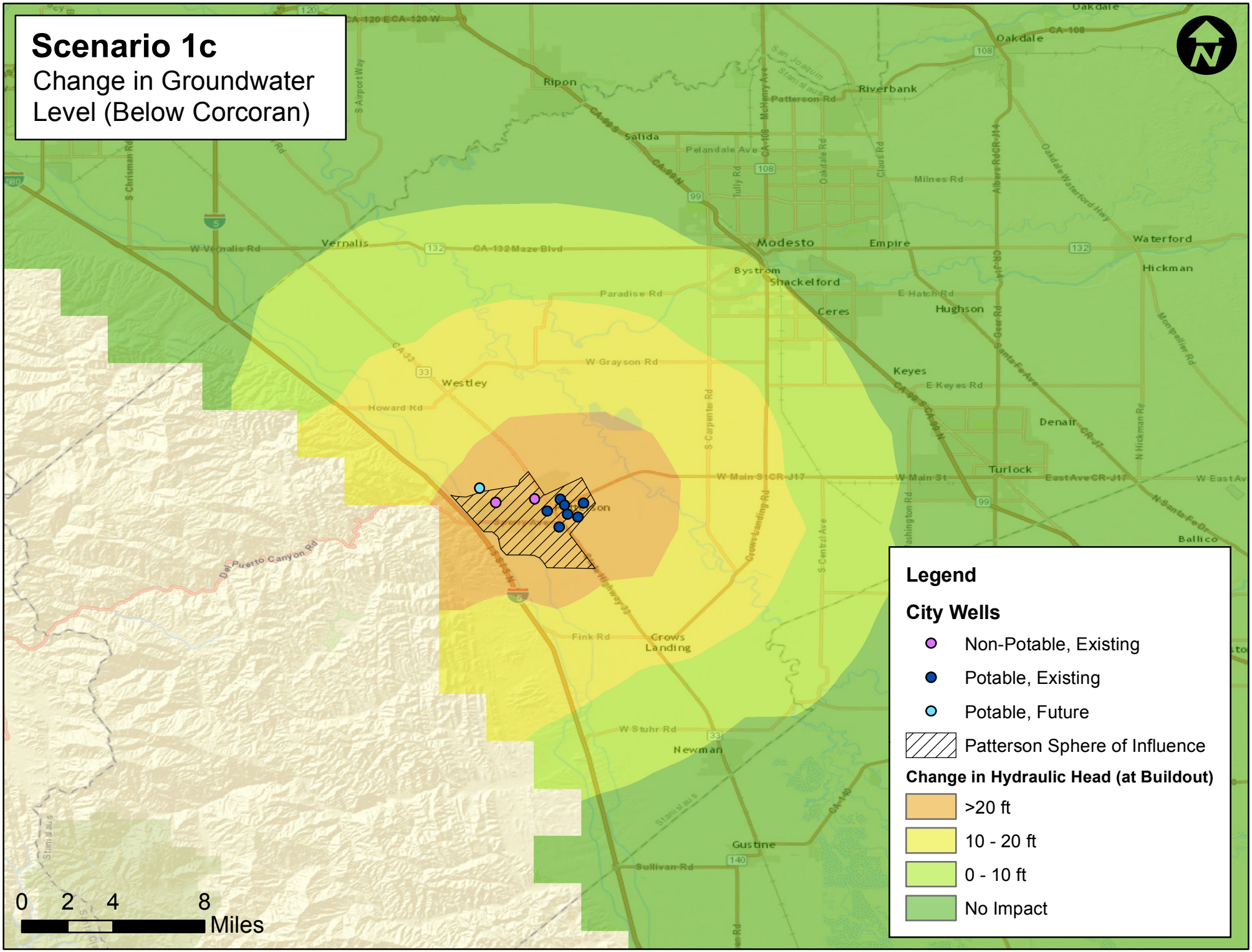
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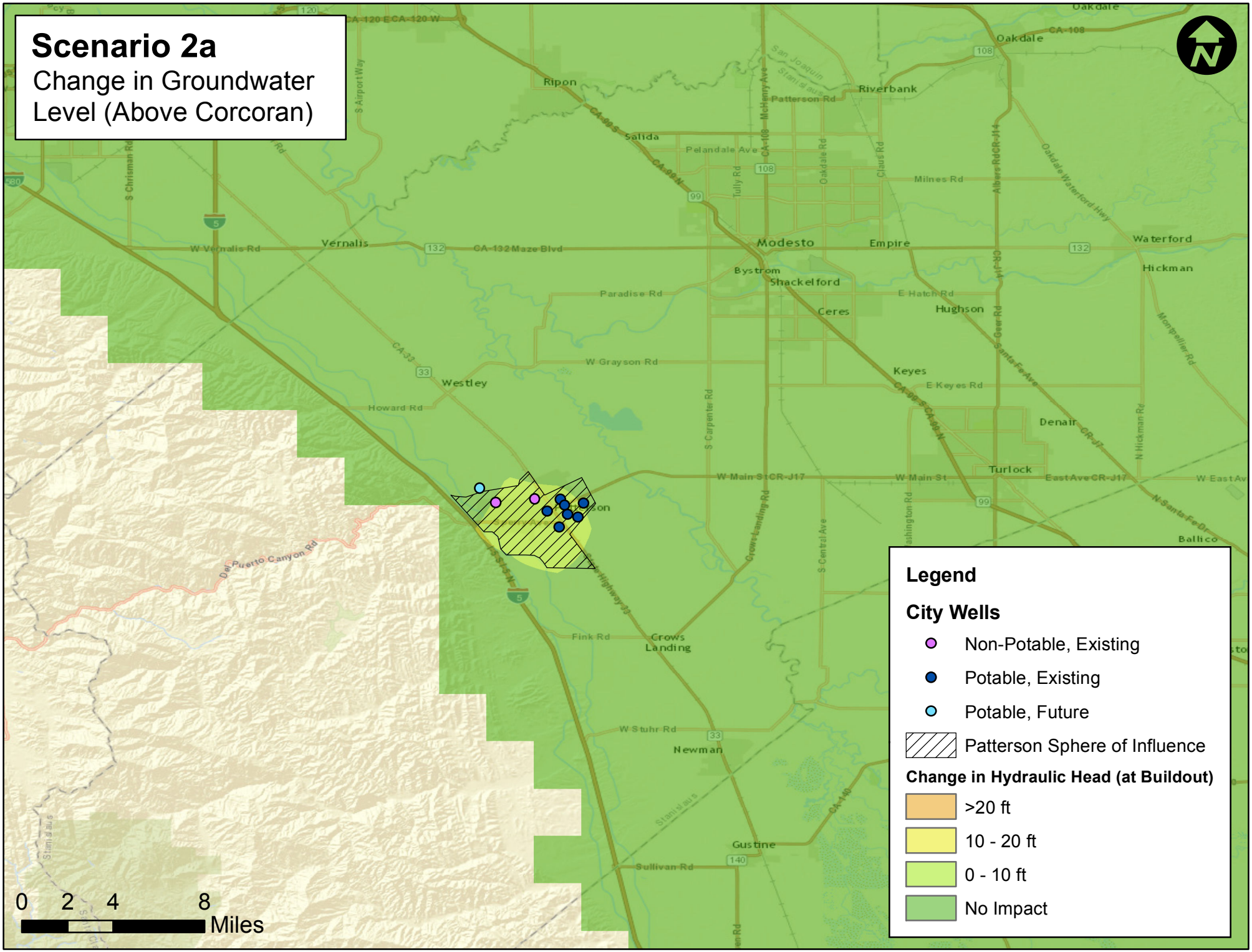
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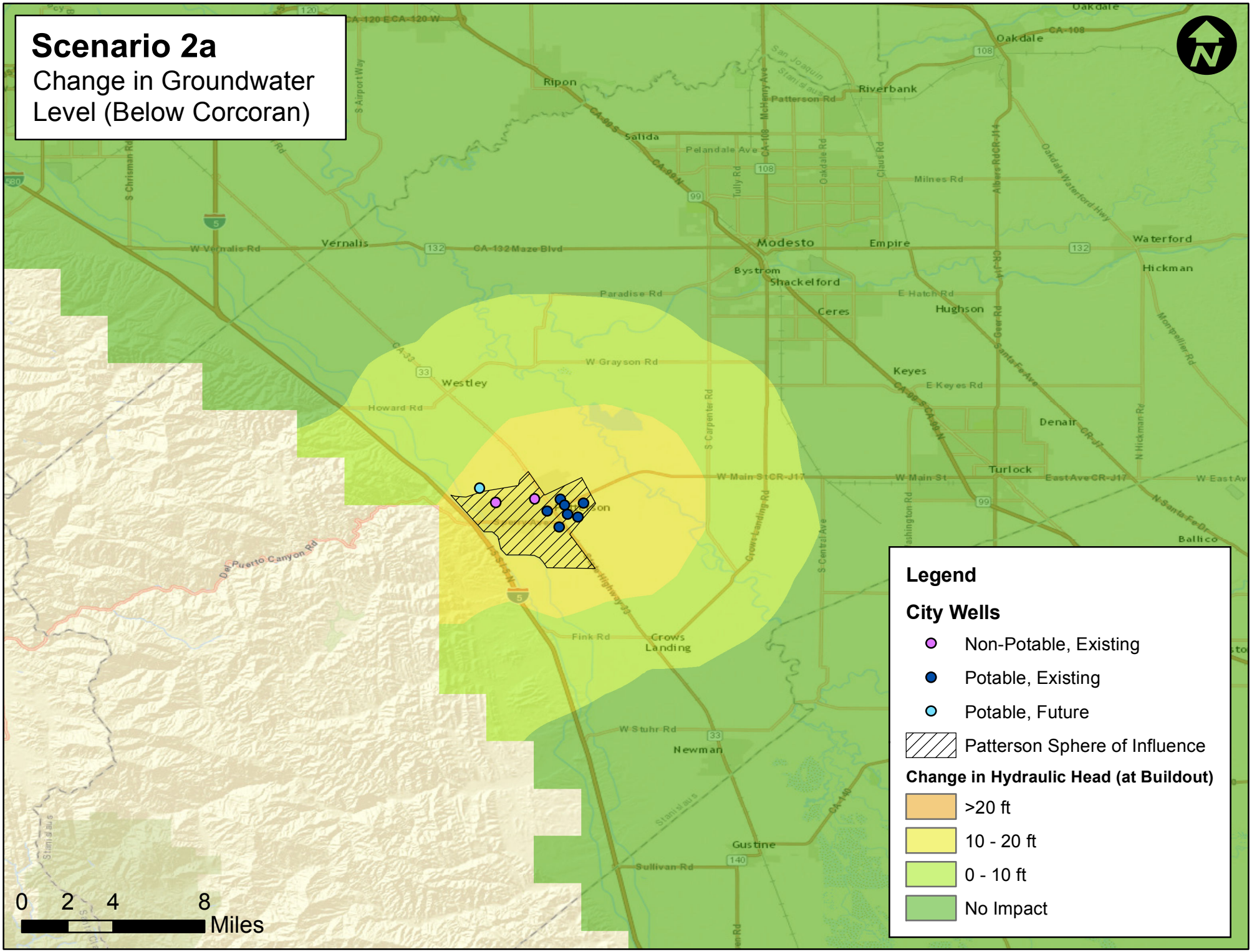
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Change in Groundwater Level (Below Corcoran)
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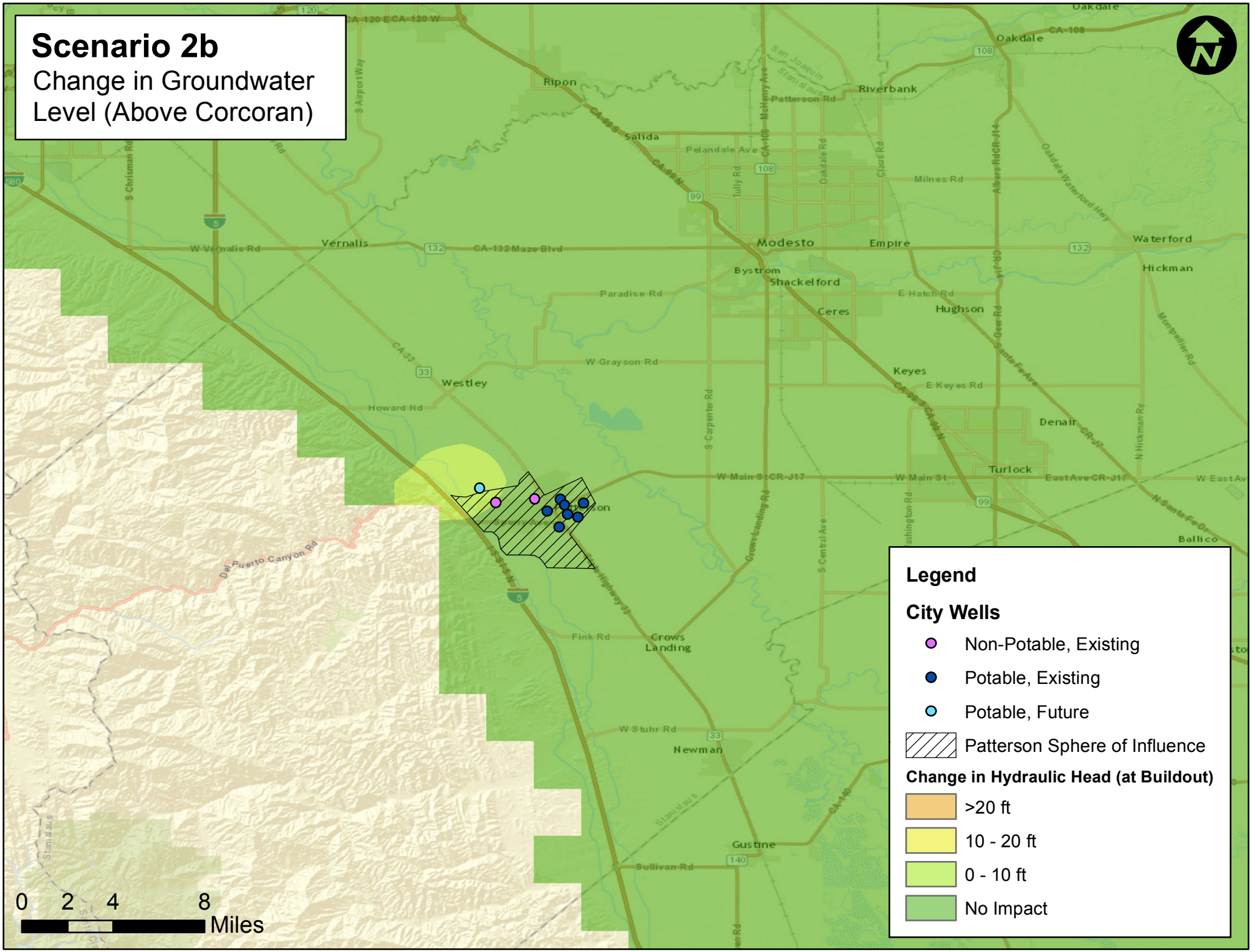
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Change in Groundwater Level (Above Corcoran)
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City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
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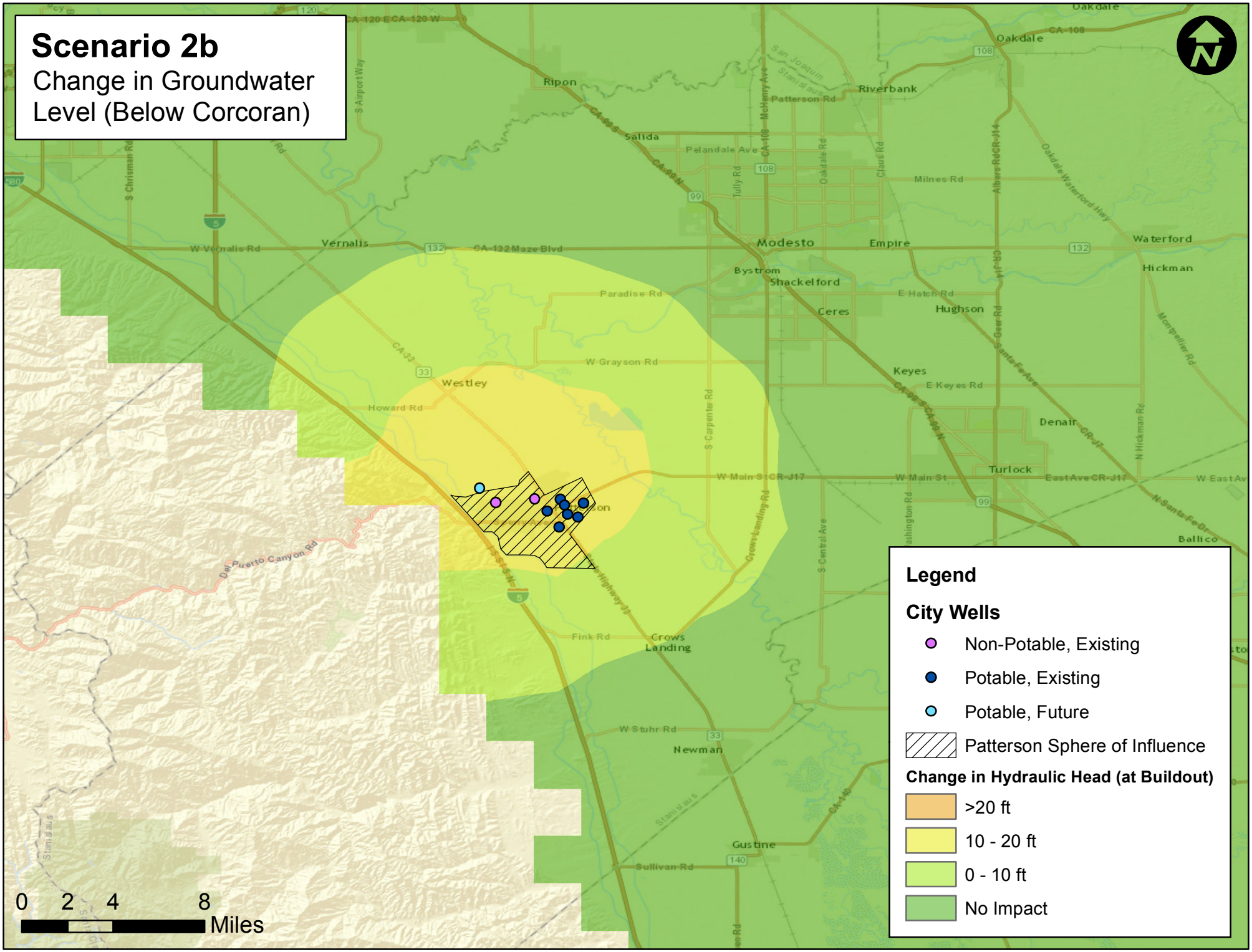
Scenario 2b
Change in Groundwater Level (Below Corcoran)
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Potable, Existing
Potable, Future
Patterson Sphere of Influence
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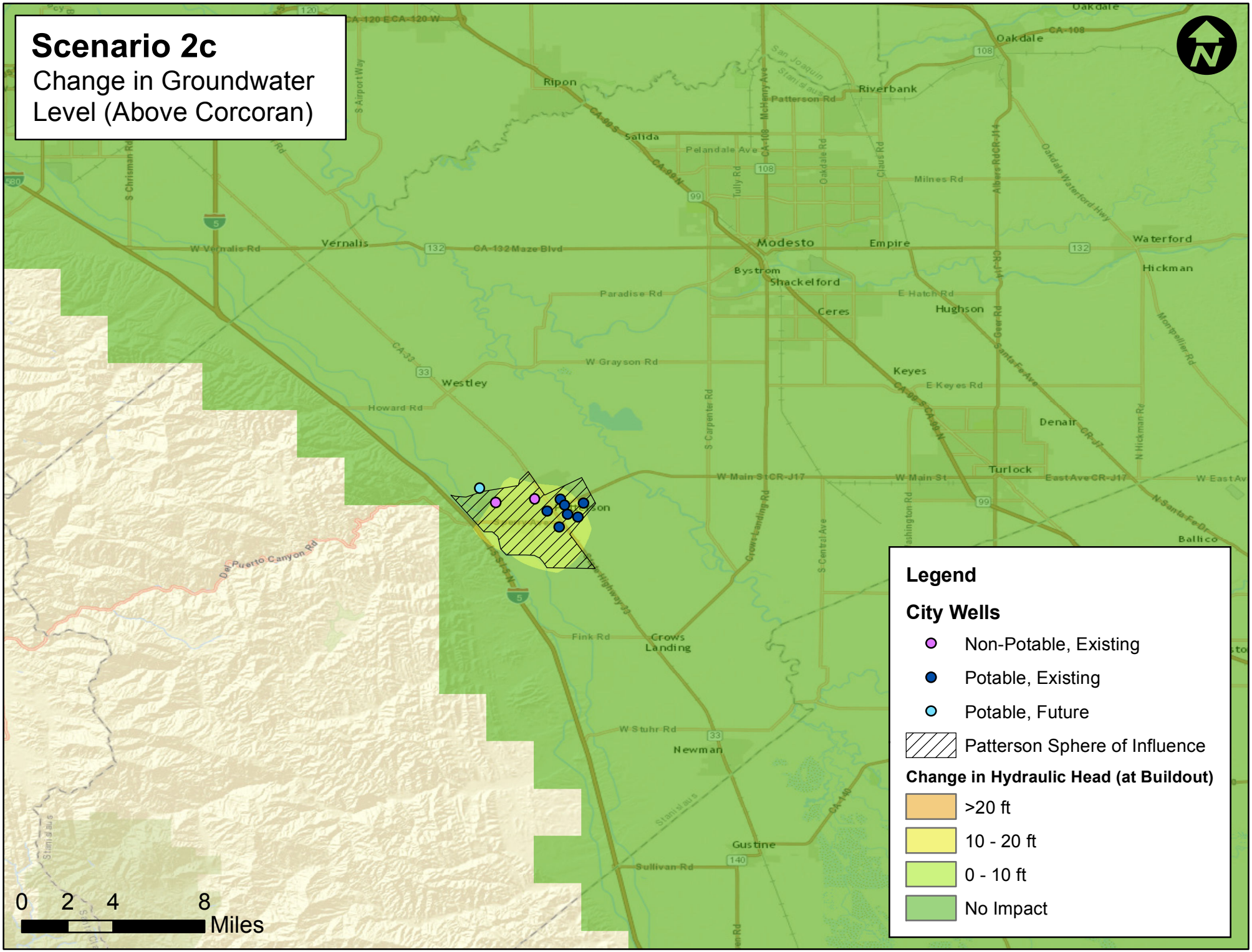
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Change in Groundwater Level (Above Corcoran)
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City Wells
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Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
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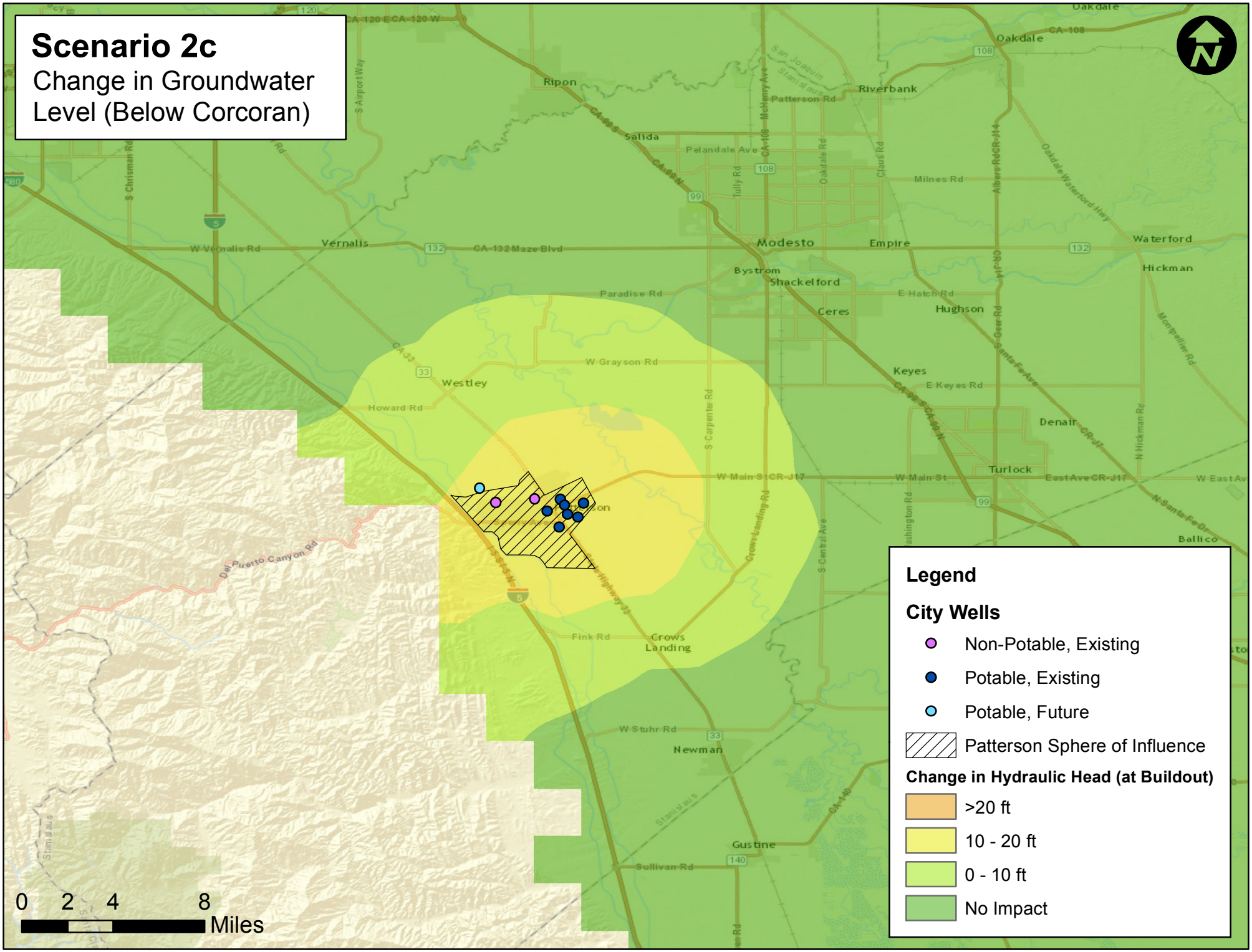
Scenario 2c
Change in Groundwater Level (Below Corcoran)
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City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
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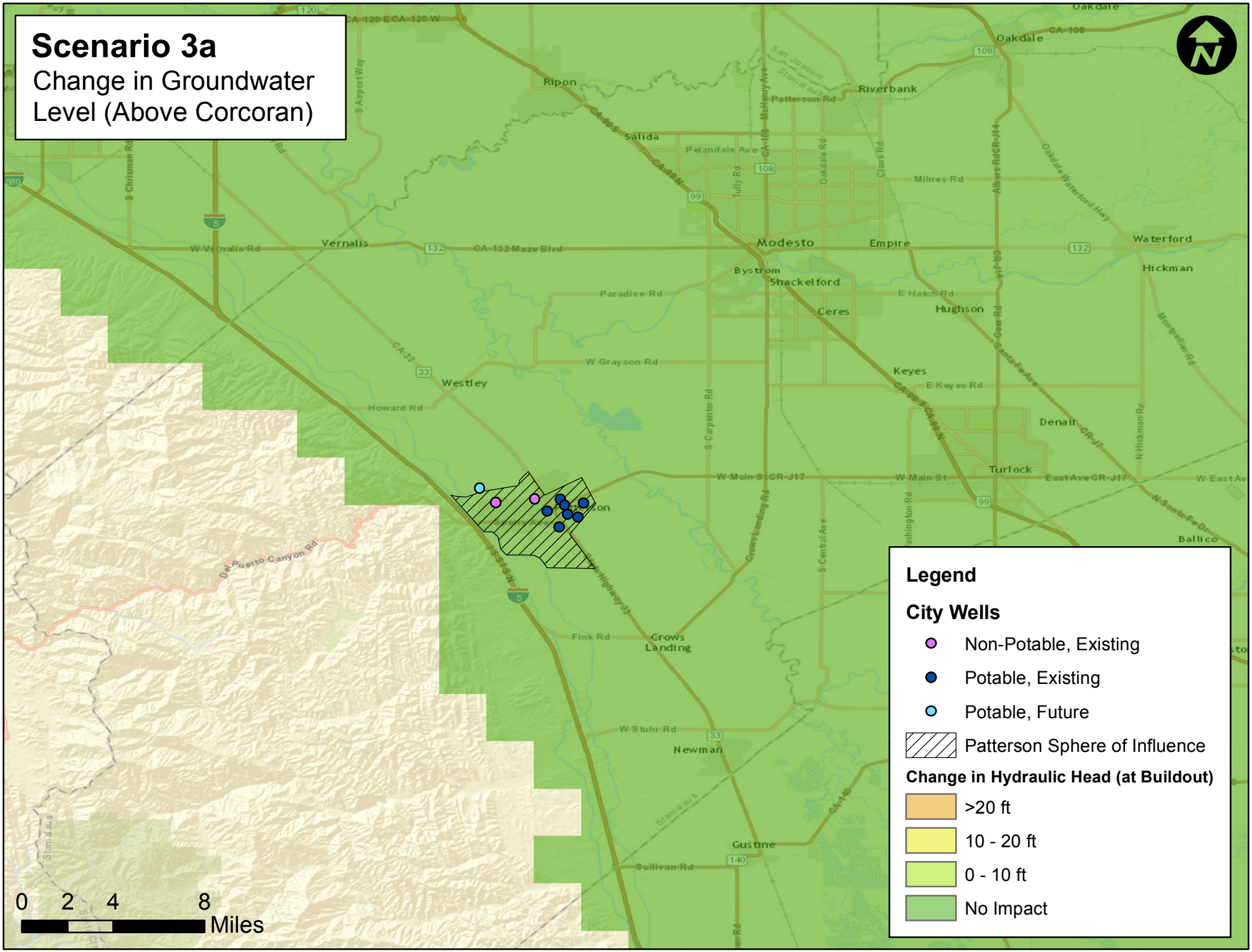
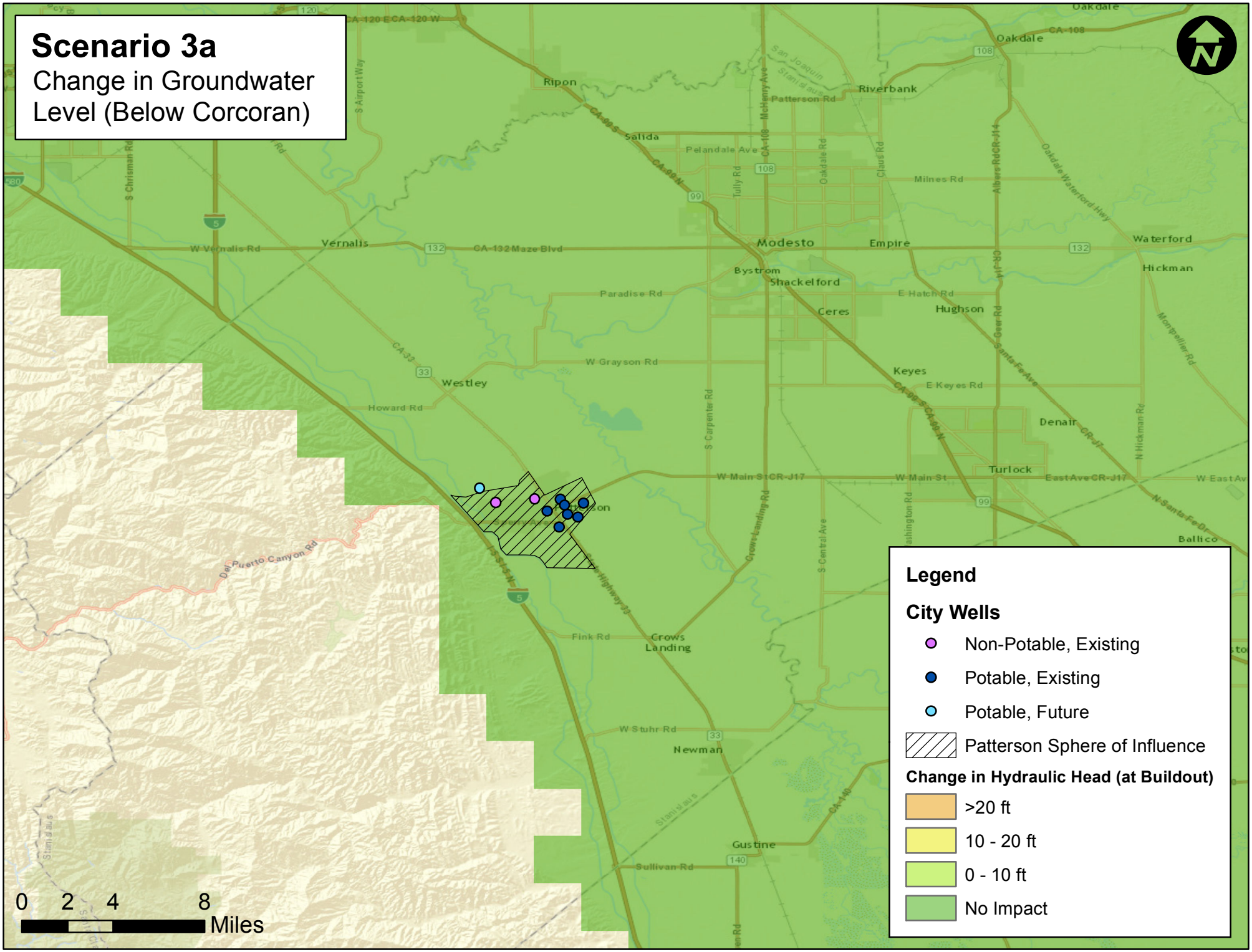
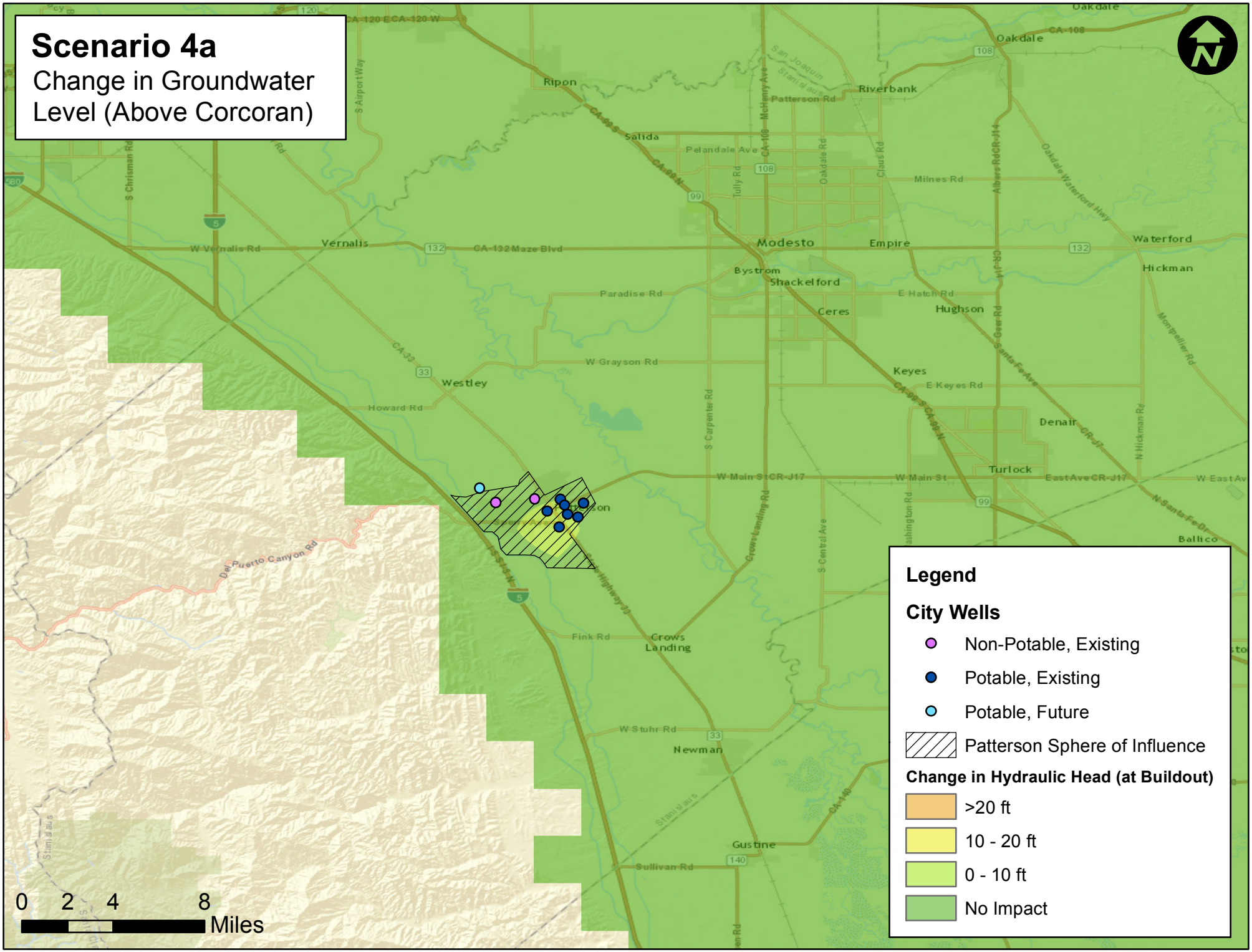
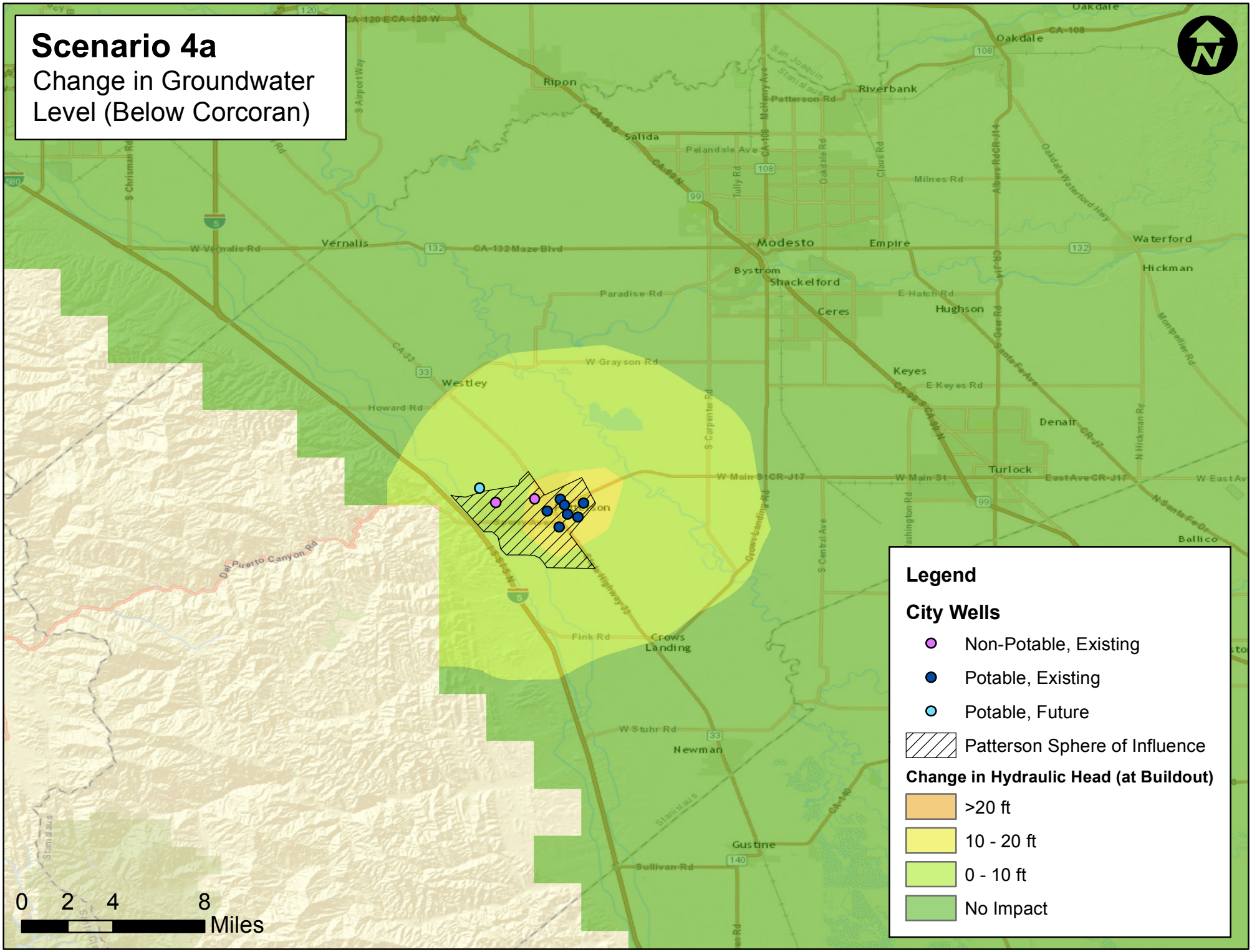
0 - 10 ft
No Impact


Scenario 3a
Change in Groundwater Level (Above Corcoran)
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
10 - 20 ft
0 - 10 ft
No Impact
0 2 4 8
Miles
Ripon
Salida
Riverbank
Oakdale
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Vernalis
Westley
Keyes
Denair
Turlock
Crows Landing
Newman
Gustine
Ballico
Patterson
Paradise Rd
W Grayson Rd
Howard Rd
Del Puerto Canyon Rd
Fink Rd
W Stuhr Rd
Sullivan Rd
W Vernalis Rd
CA-132 Maze Blvd
Milnes Rd
Pelandale Ave
Patterson Rd
E Hatch Rd
E Keyes Rd
W Main St
CR-J17
East Ave
Claus Rd
Oakdale Rd
S Carpenter Rd
Crows Landing Rd
S Central Ave
N Hickman Rd
Santa Fe Ave
Geer Rd
Albers Rd
Montpelier Rd
Oakdale Waterford Hwy
CA-99 S
CA-99 N
CA-33
CA-120 E
CA-120 W
CA-108
CA-140
Interstate 5
Interstate 5 N
San Joaquin
Stanislaus
S Airport Way
S Chrisman Rd
Tully Rd
McHenry Ave
Fresno Slough
Delta Mendota Canal
Orestimba Creek
Del Puerto Creek
Del Puerto Canyon
Del Puerto Creek
Del Puerto Canyon
Del Puerto Creek
Del Puerto Canyon


Scenario 3a
Change in Groundwater Level (Below Corcoran)
Ripon
Riverbank
Oakdale
Salida
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Vernalis
Westley
Keyes
Denair
Turlock
Crows Landing
Newman
Gustine
Patterson
Del Puerto Canyon Rd
Fink Rd
W Stuhr Rd
Sullivan Rd
Howard Rd
W Grayson Rd
Paradise Rd
Milnes Rd
Pelandale Ave
Patterson Rd
W Main St
E Keyes Rd
E Hatch Rd
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
10 - 20 ft
0 - 10 ft
No Impact
0 2 4 8
Miles


Scenario 4a
Change in Groundwater Level (Above Corcoran)
Ripon
Riverbank
Oakdale
Salida
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Vernalis
Westley
Keyes
Denair
Turlock
Crows Landing
Newman
Gustine
Ballico
Del Puerto Canyon Rd
Fink Rd
W Stuhr Rd
Sullivan Rd
Howard Rd
W Grayson Rd
Paradise Rd
Pelandale Ave
Patterson Rd
Milnes Rd
E Hatch Rd
E Keyes Rd
W Main St
CA-120 E
CA-120 W
CA-99 S
CA-99 N
CA-132 Maze Blvd
CA-33
CA-140
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
10 - 20 ft
0 - 10 ft
No Impact
0 2 4 8
Miles


Scenario 4a
Change in Groundwater Level (Below Corcoran)
Legend
City Wells
Non-Potable, Existing
Potable, Existing
Potable, Future
Patterson Sphere of Influence
Change in Hydraulic Head (at Buildout)
>20 ft
10 - 20 ft
0 - 10 ft
No Impact
0 2 4 8
Miles
Ripon
Salida
Riverbank
Oakdale
Modesto
Empire
Waterford
Hickman
Bystrom
Shackelford
Ceres
Hughson
Keyes
Denair
Turlock
Westley
Vernalis
Crows Landing
Newman
Gustine
Ballico
Paradise Rd
W Grayson Rd
Howard Rd
Fink Rd
W Stuhr Rd
Sullivan Rd
Del Puerto Canyon Rd
Patterson Rd
Pelandale Ave
Milnes Rd
E Hatch Rd
E Keyes Rd
W Main St
W Main St CR-J17
East Ave CR-J17
W Vernalis Rd
CA-132 Maze Blvd
CA-33
CA-99 S
CA-99 N
CA-108
CA-120 E
CA-120 W
CA-140
S Airport Way
S Carpenter Rd
S Central Ave
Tully Rd
Oakdale Rd
Claus Rd
Albers Rd
Geer Rd
Santa Fe Ave
N Hickman Rd
Montpelier Rd
Oakdale Waterford Hwy
Crows Landing Rd
Washington Rd
N Santa Fe Dr
San Joaquin
Stanislaus
Interstate 5
Interstate 5 N
Interstate 5 S
Del Puerto Canyon
Fresno
Merced
Stanislaus

6 Appendix B: Groundwater Hydrographs

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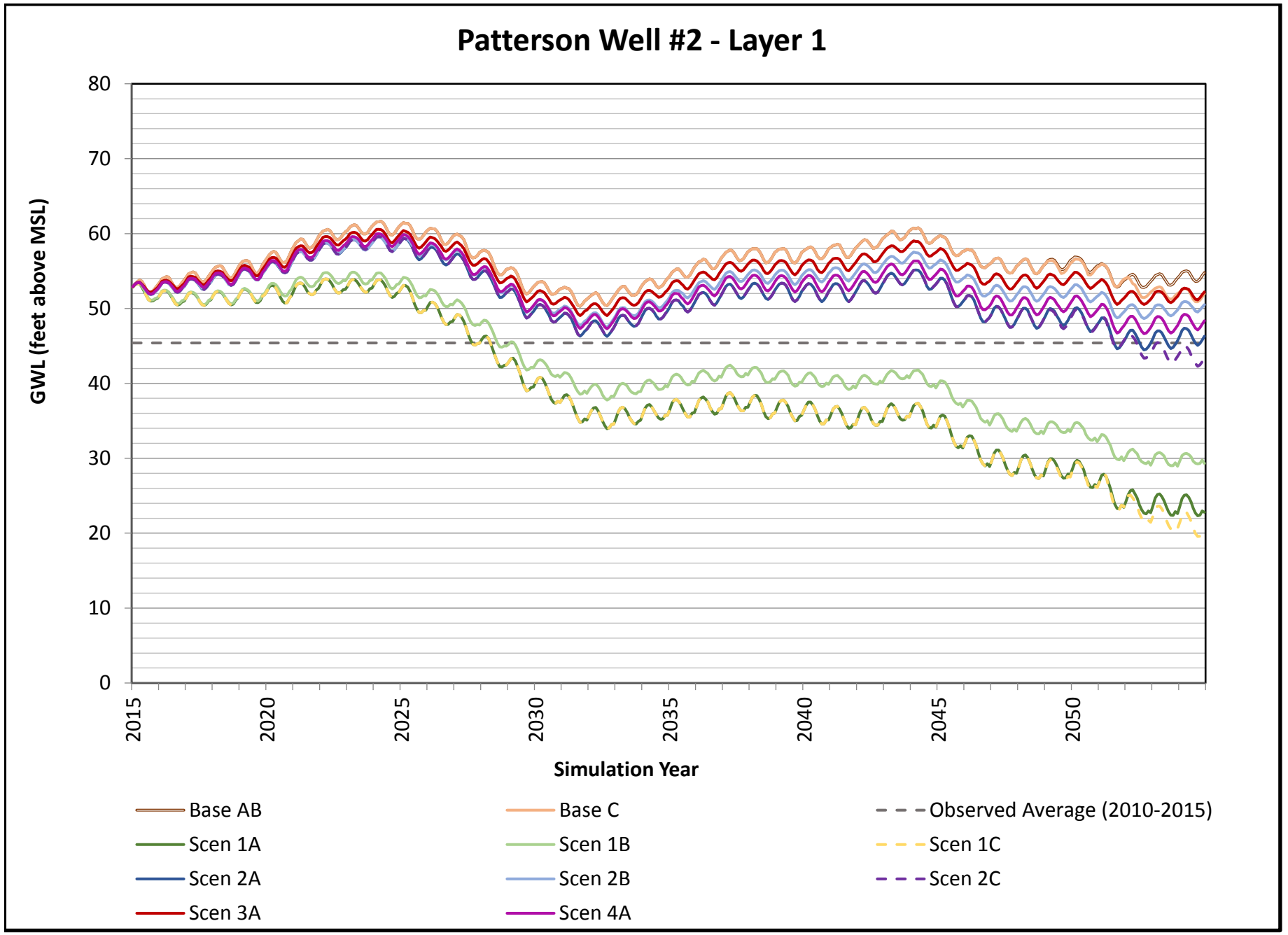
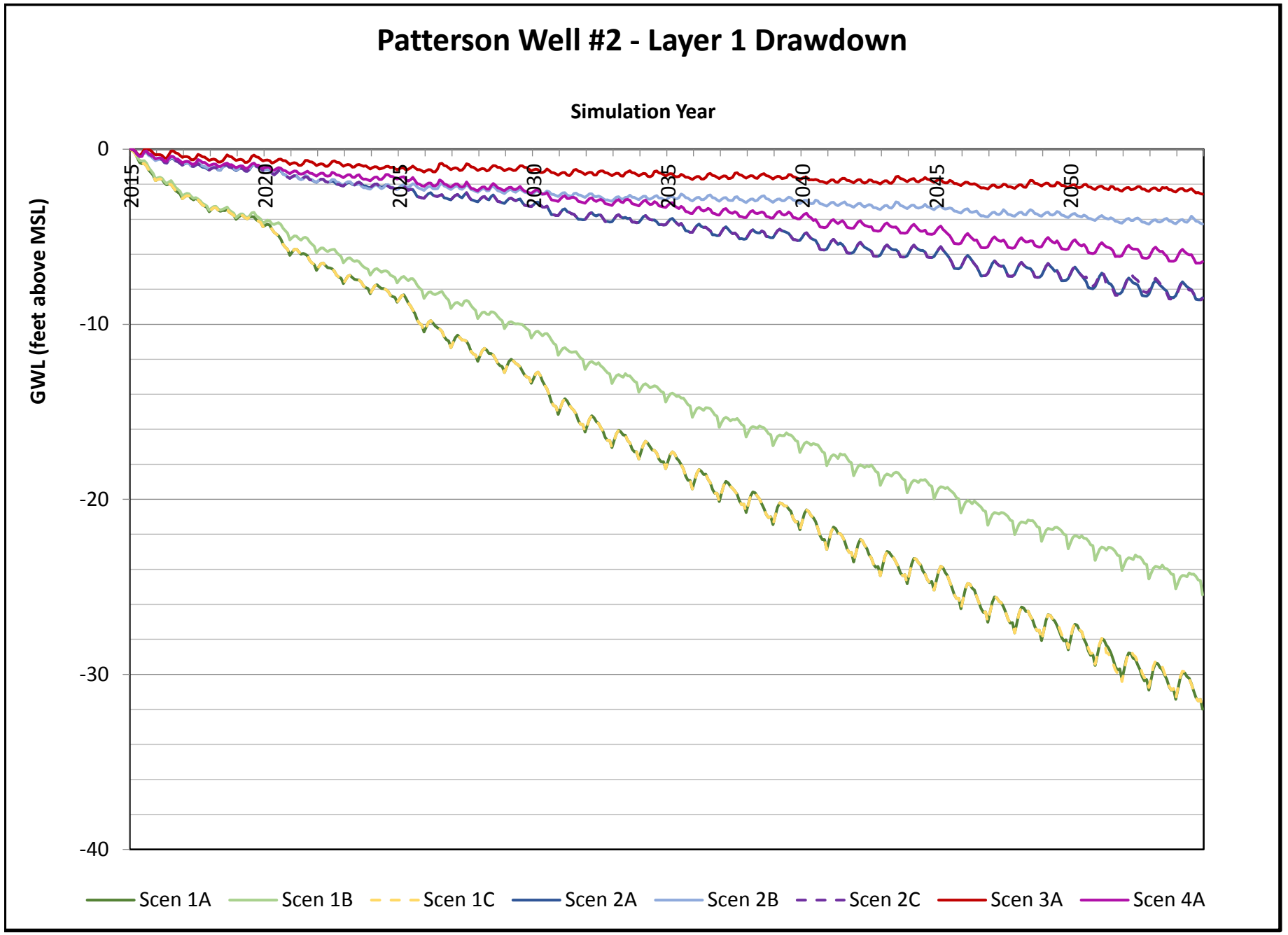
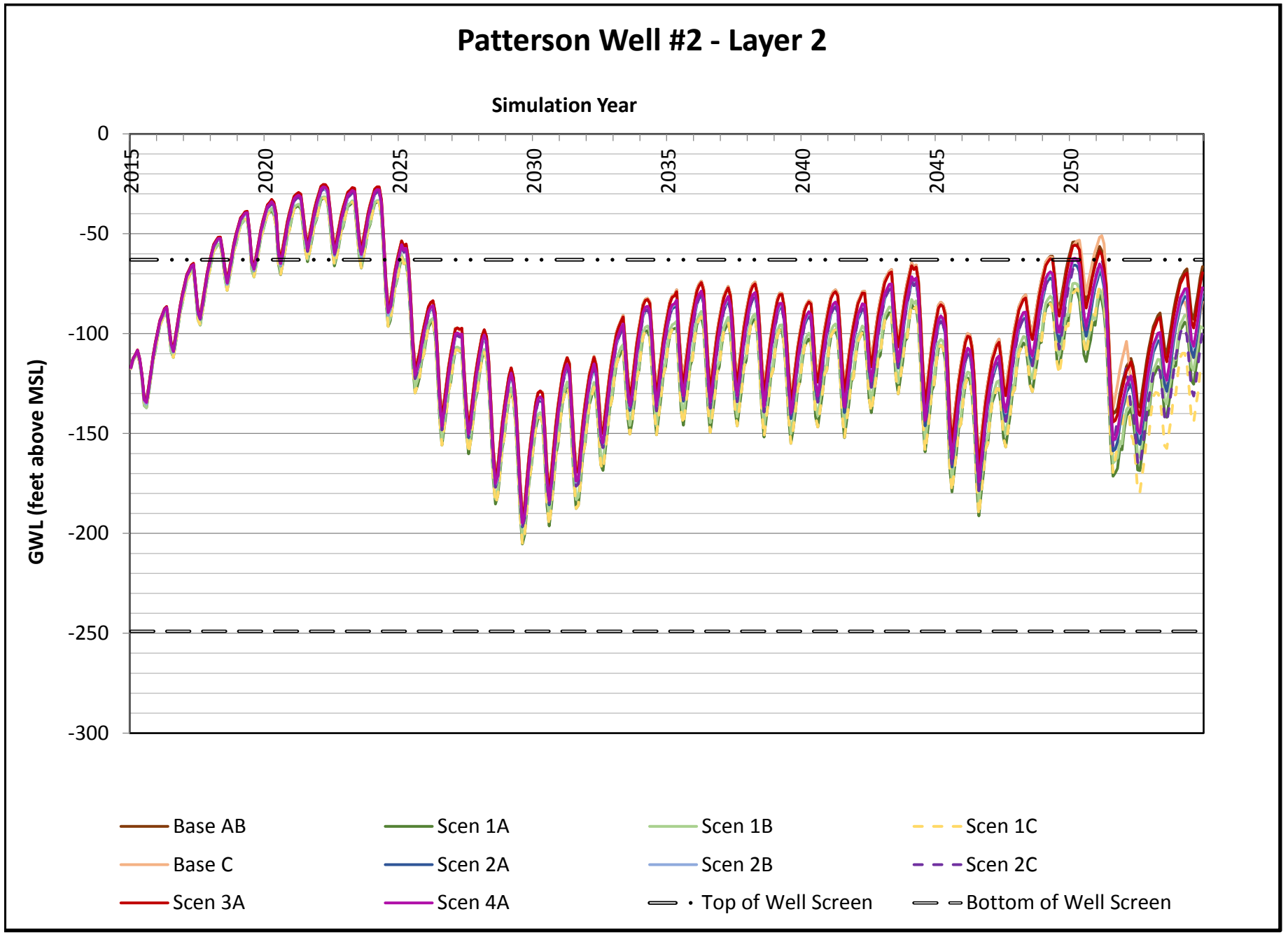
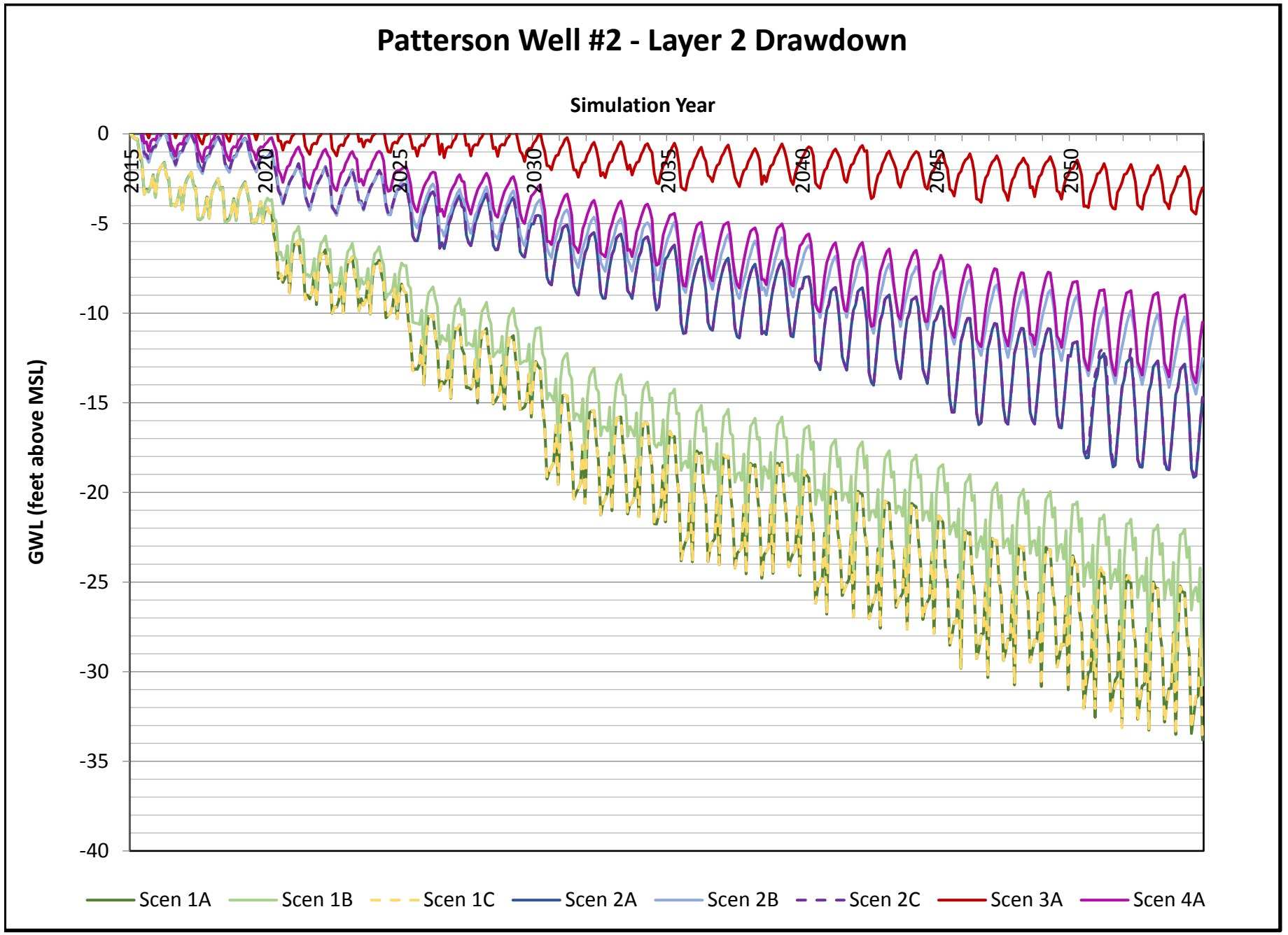
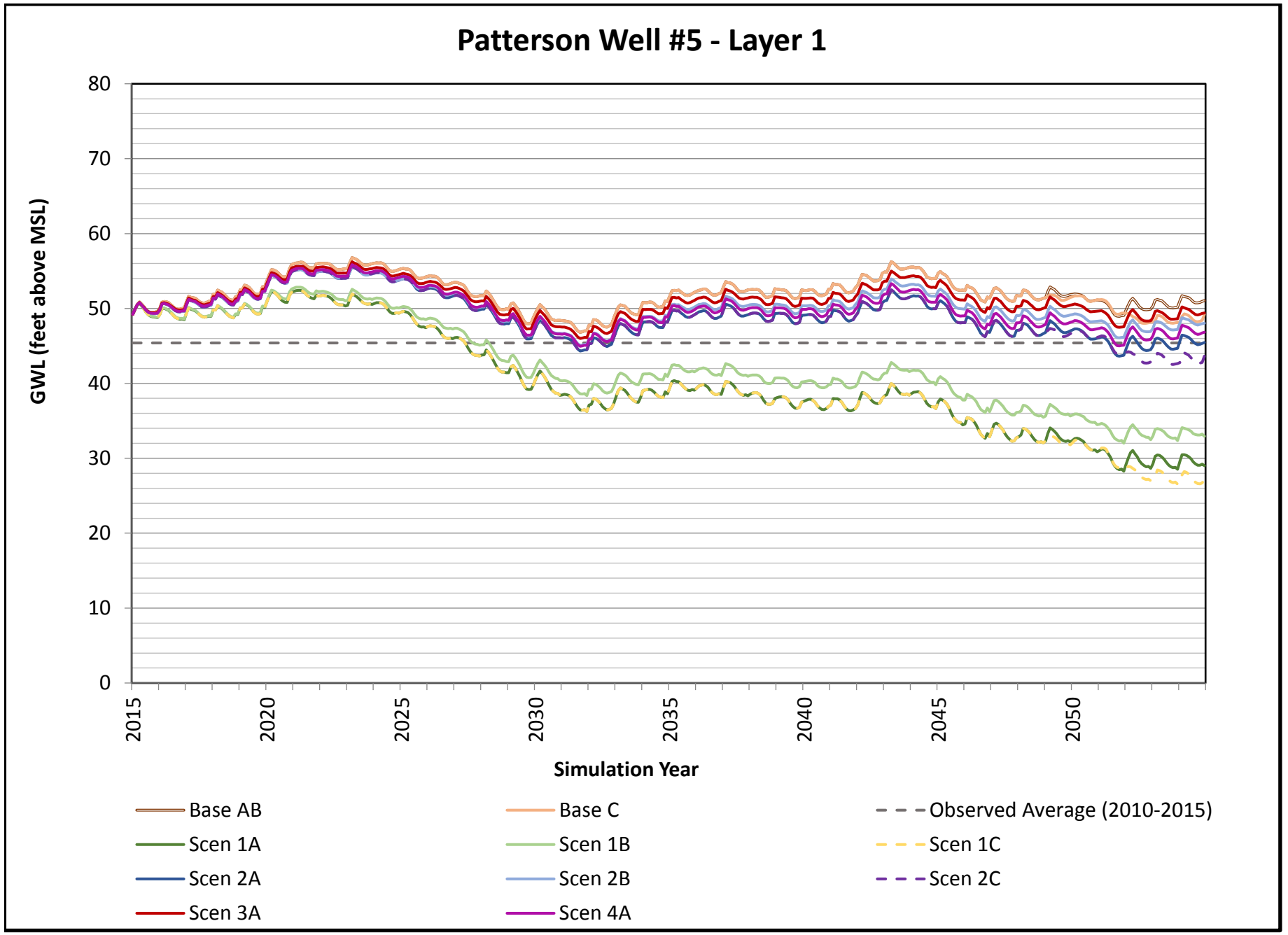
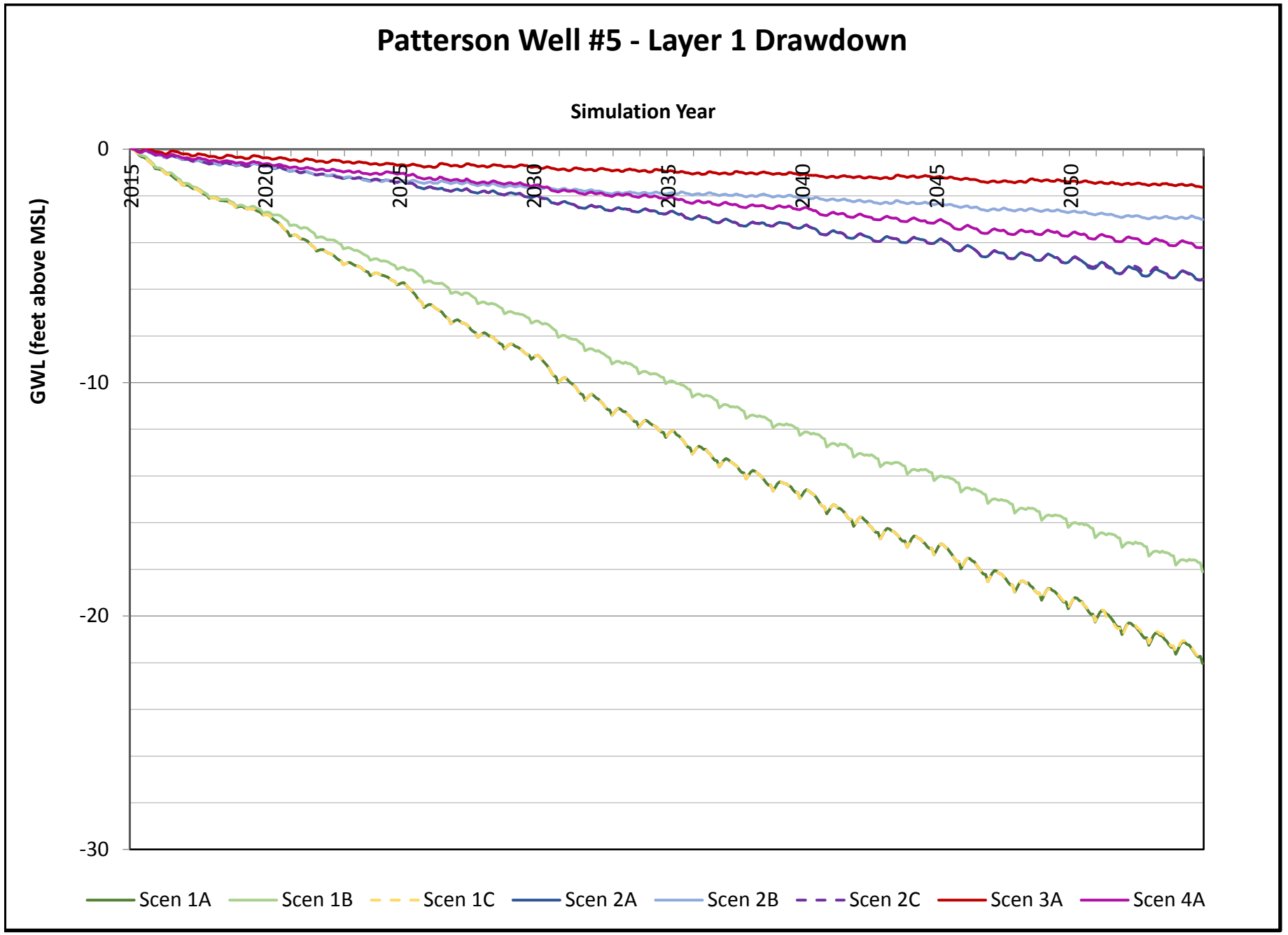

Patterson Well #2 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

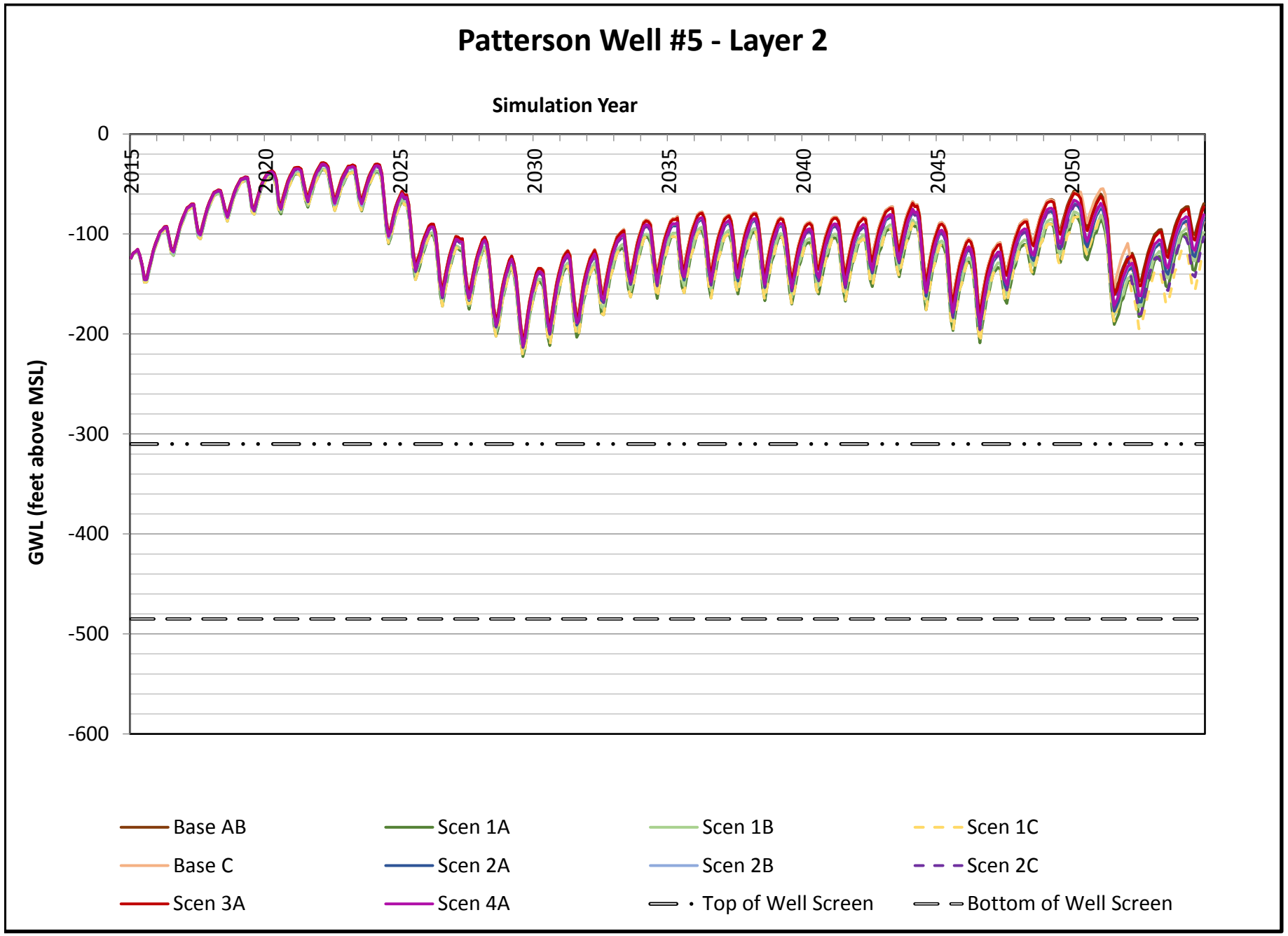

Patterson Well #2 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
-30
-40
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

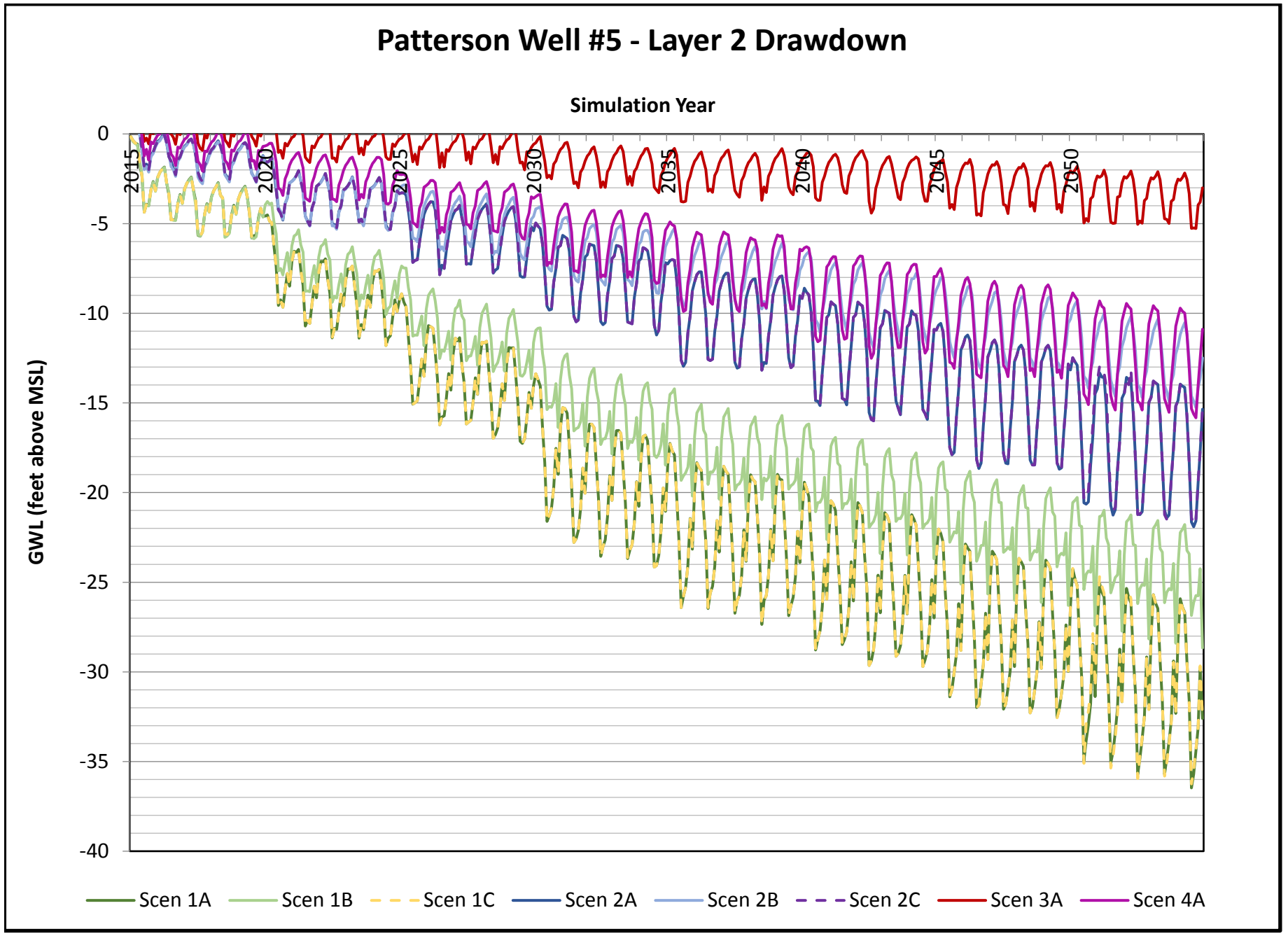

Patterson Well #2 - Layer 2
Simulation Year
0
-50
-100
-150
-200
-250
-300
2015
2020
2025
2030
2035
2040
2045
2050
GWL (feet above MSL)
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen

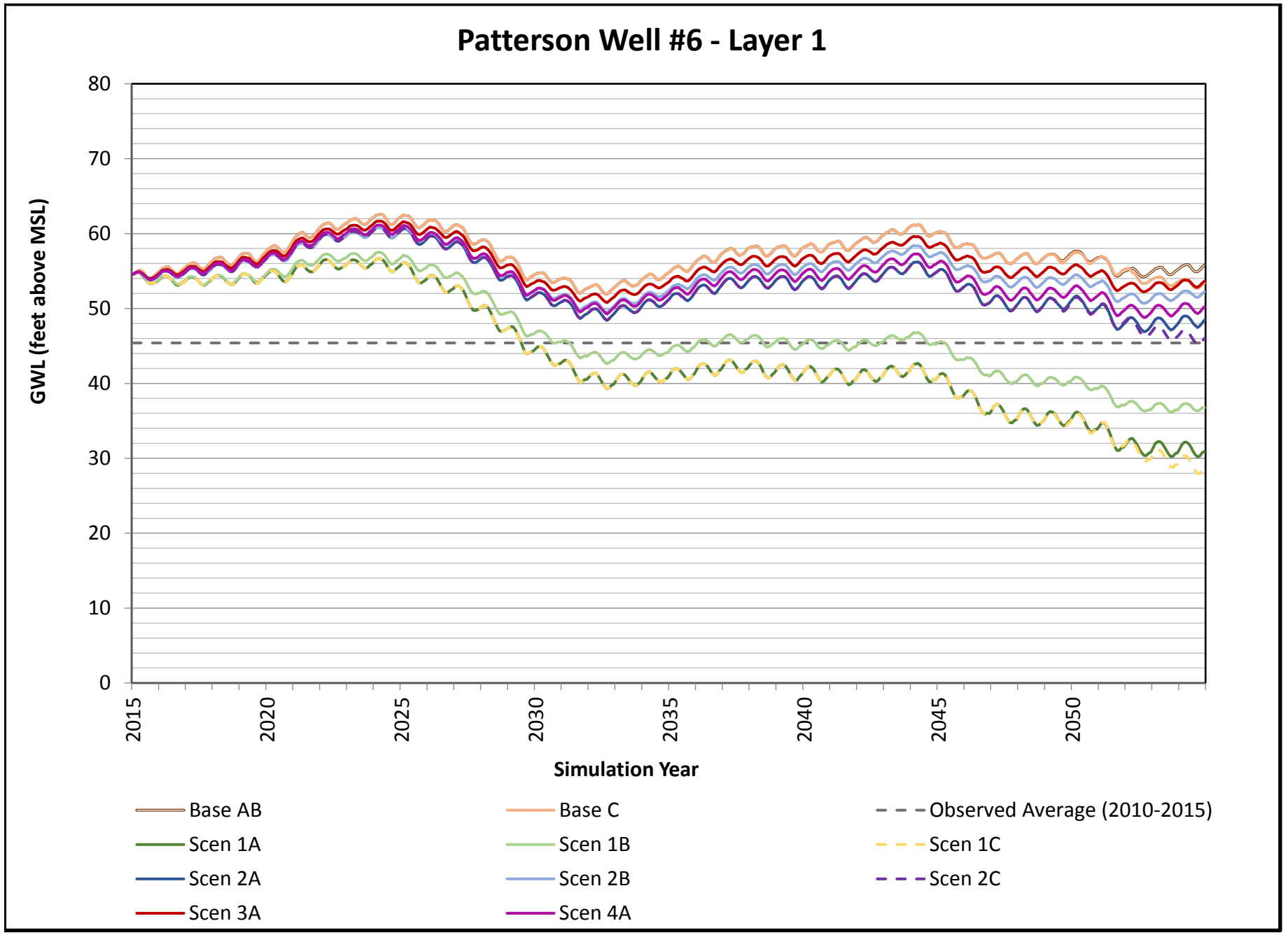

Patterson Well #2 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

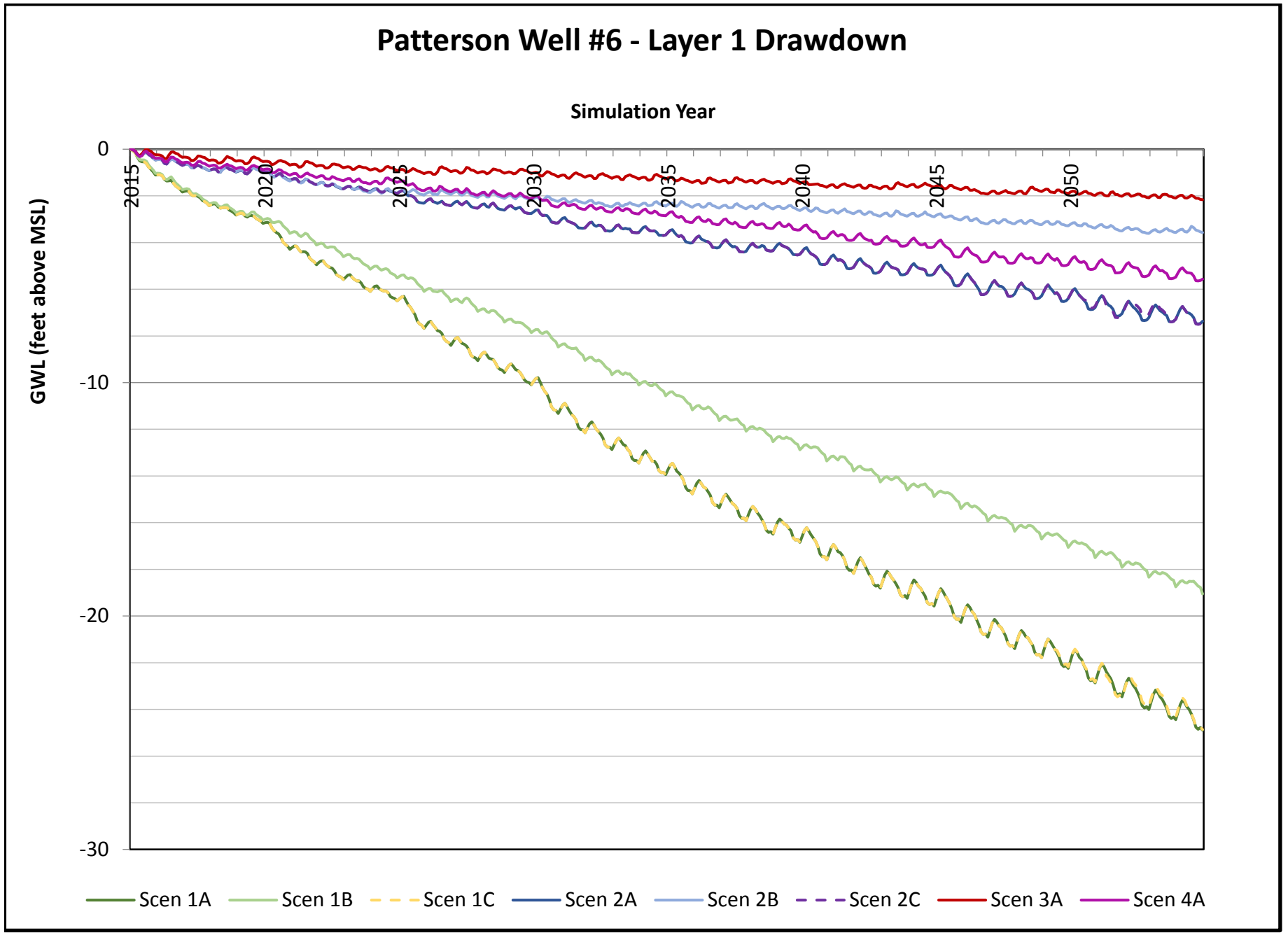

Patterson Well #5 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

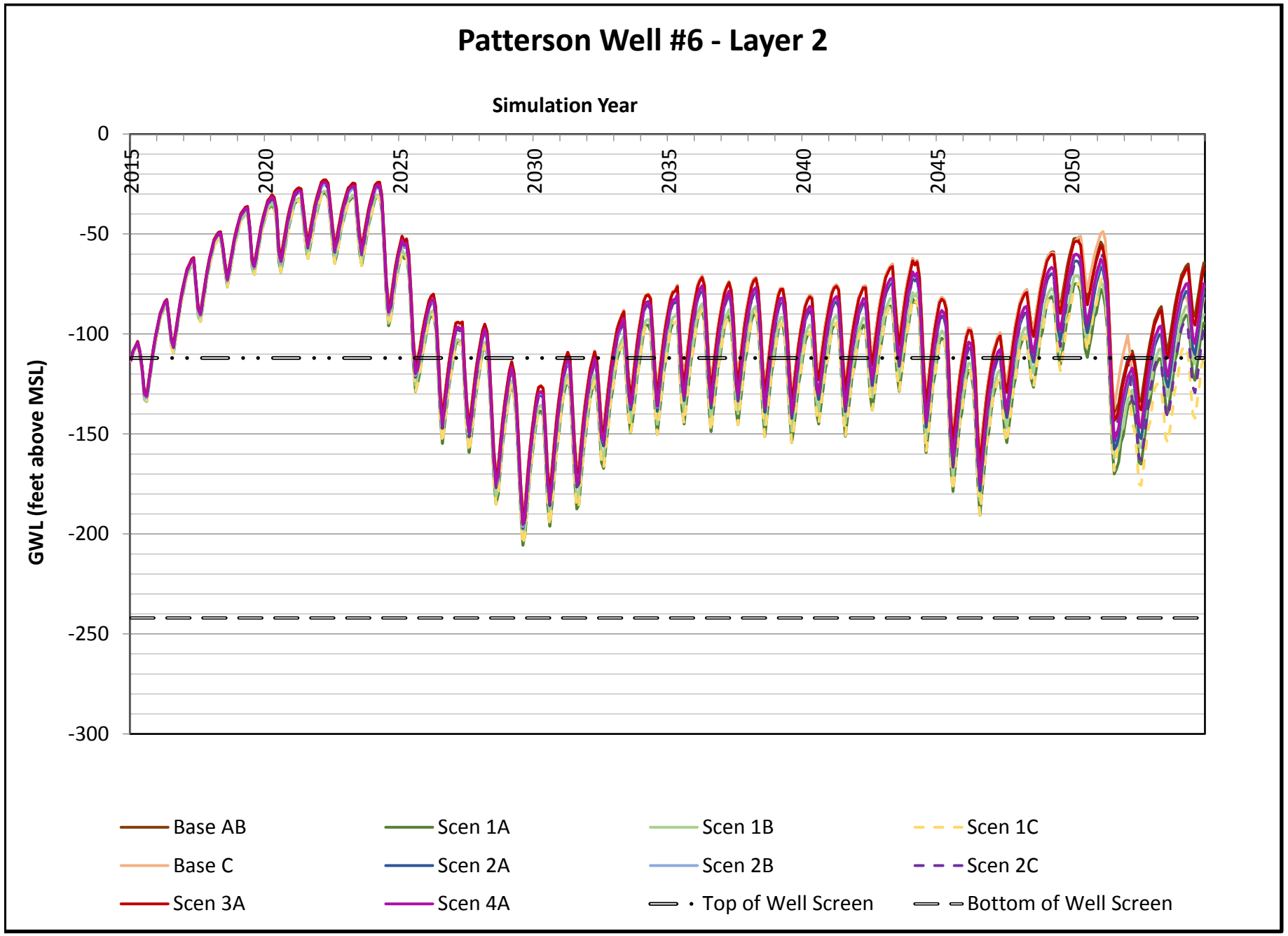

Patterson Well #5 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
-30
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

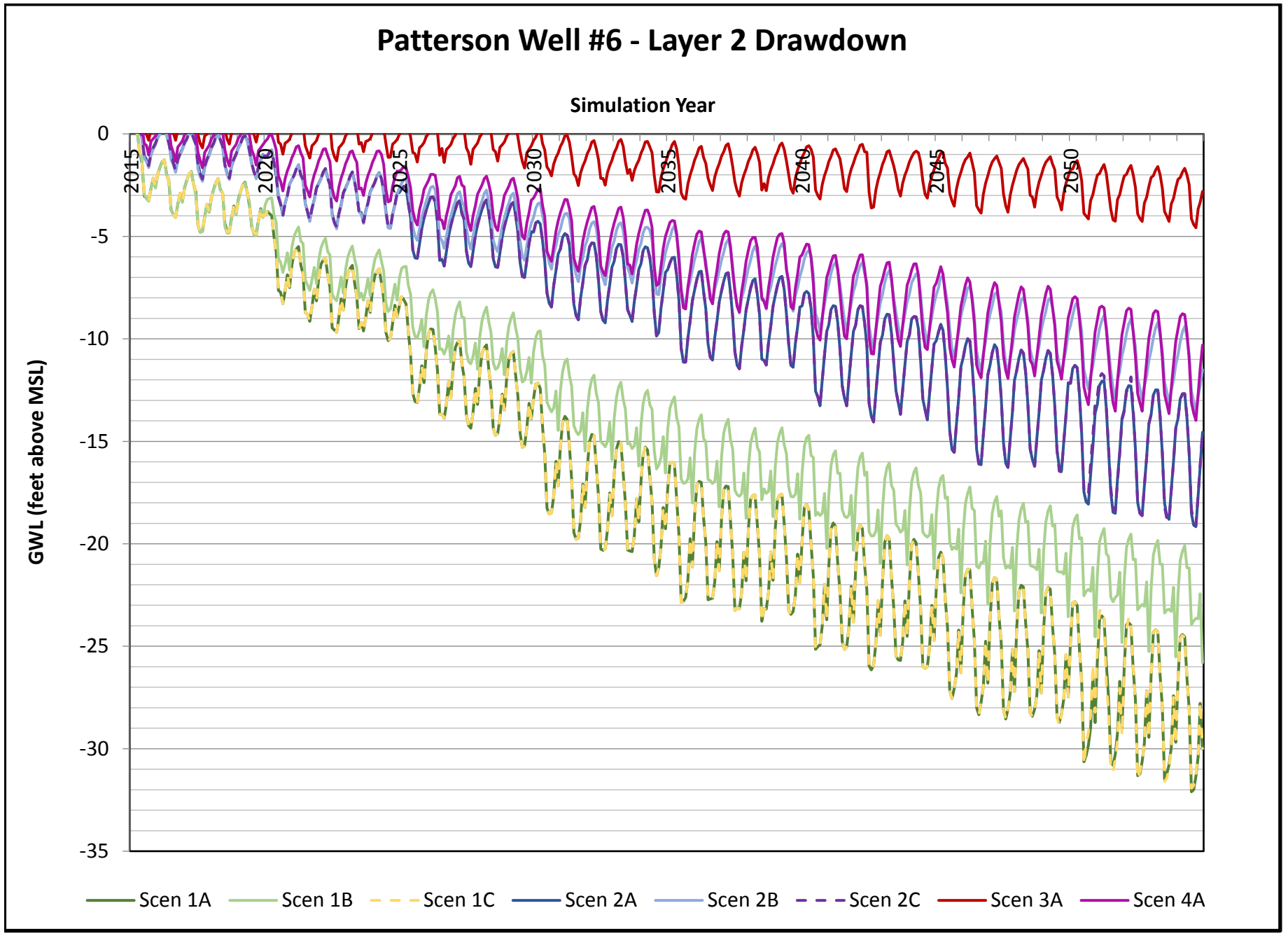

Patterson Well #5 - Layer 2
Simulation Year
0
-100
-200
-300
-400
-500
-600
2015
2020
2025
2030
2035
2040
2045
2050
GWL (feet above MSL)
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen

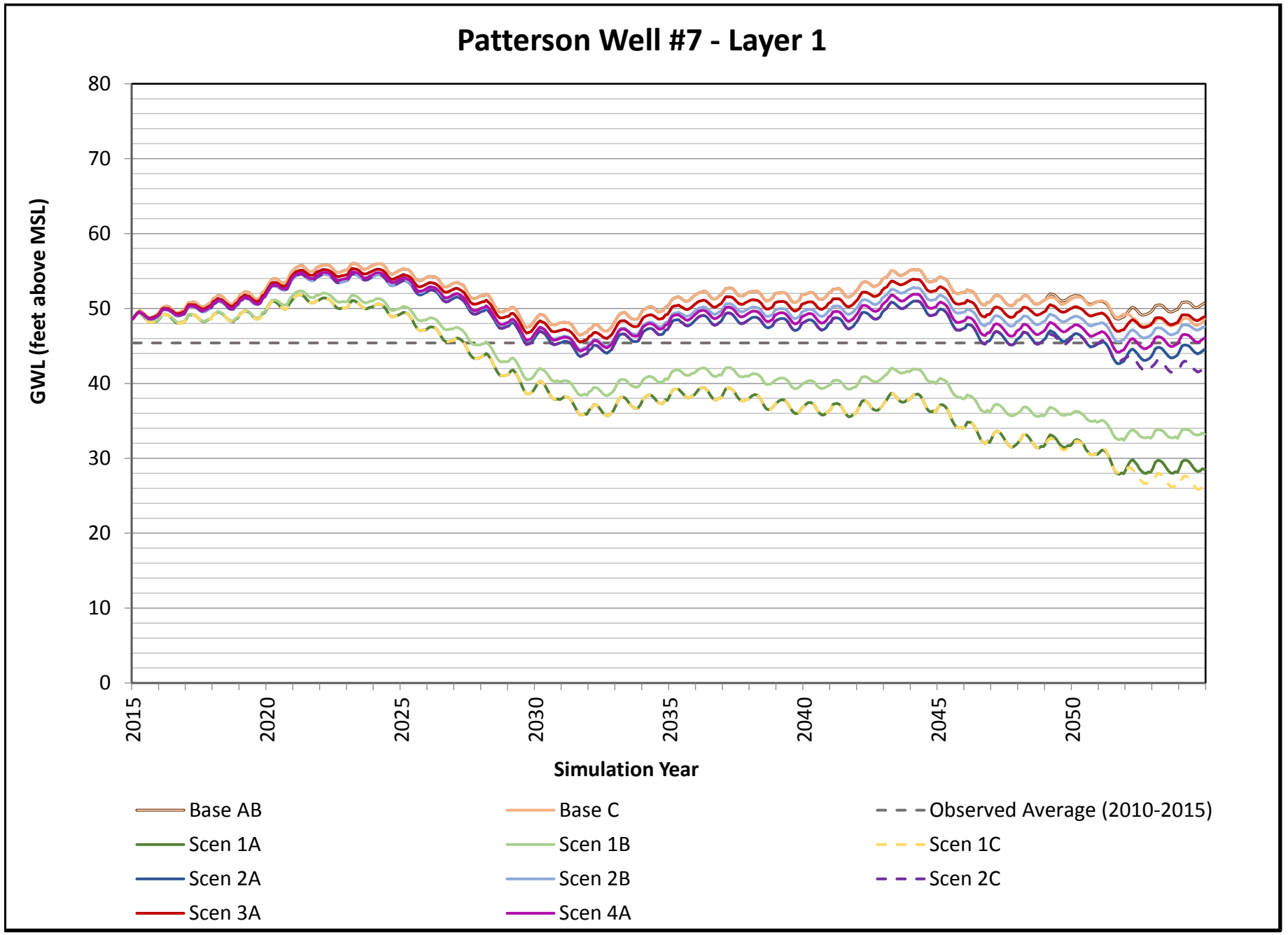

Patterson Well #5 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

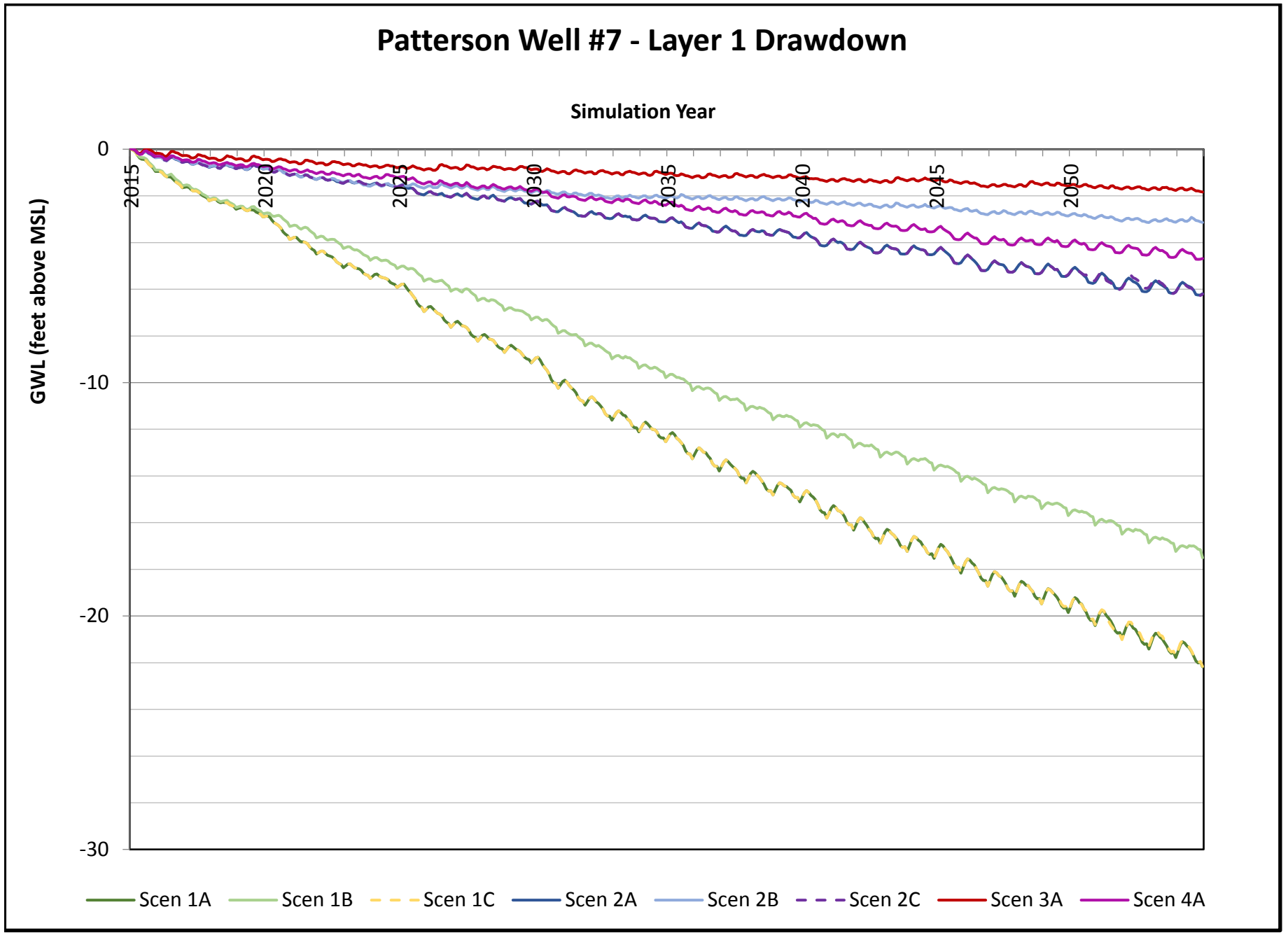

Patterson Well #6 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

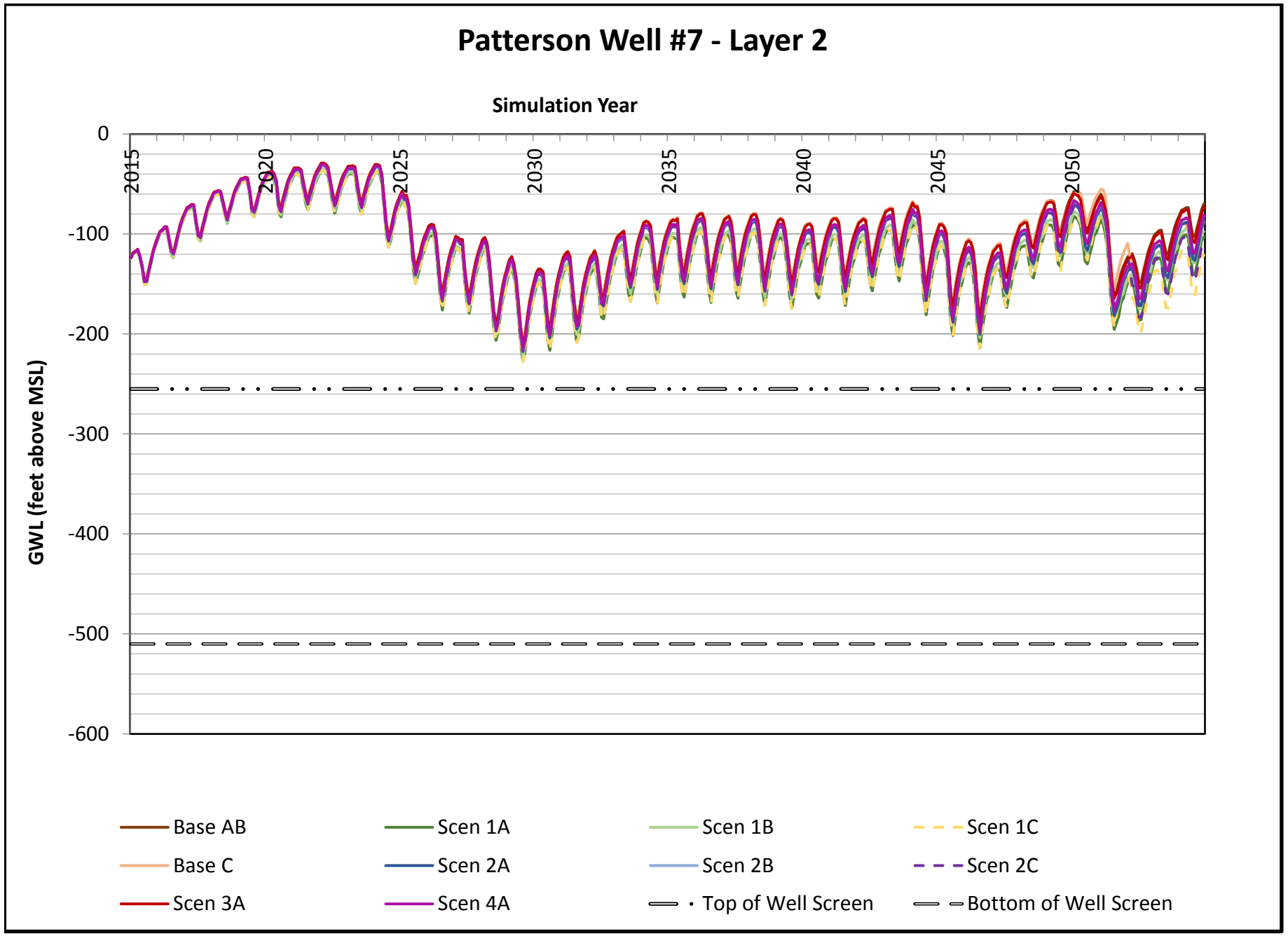

Patterson Well #6 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
-30
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

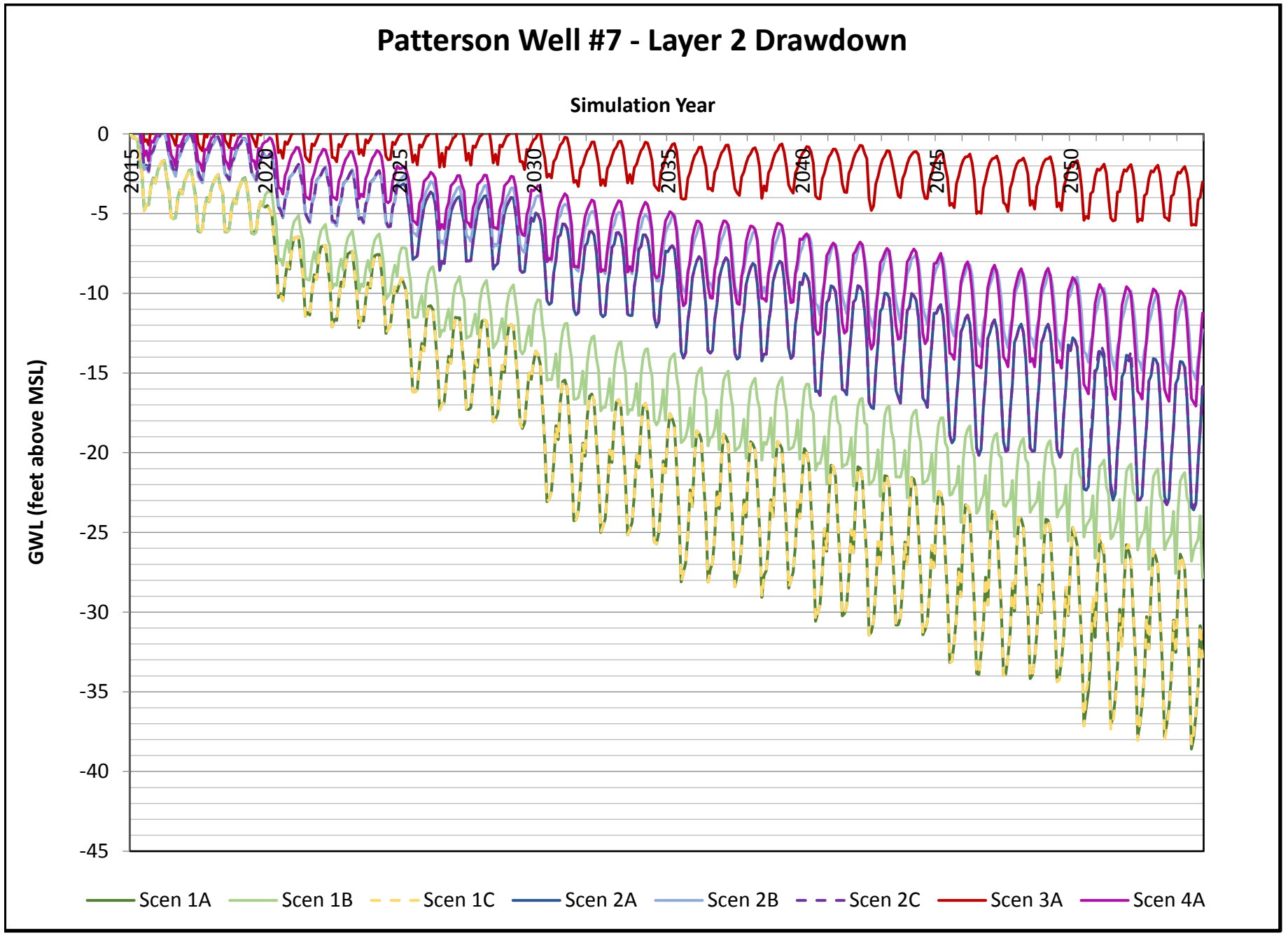

Patterson Well #6 - Layer 2
Simulation Year
0
-50
-100
-150
-200
-250
-300
2015
2020
2025
2030
2035
2040
2045
2050
GWL (feet above MSL)
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen

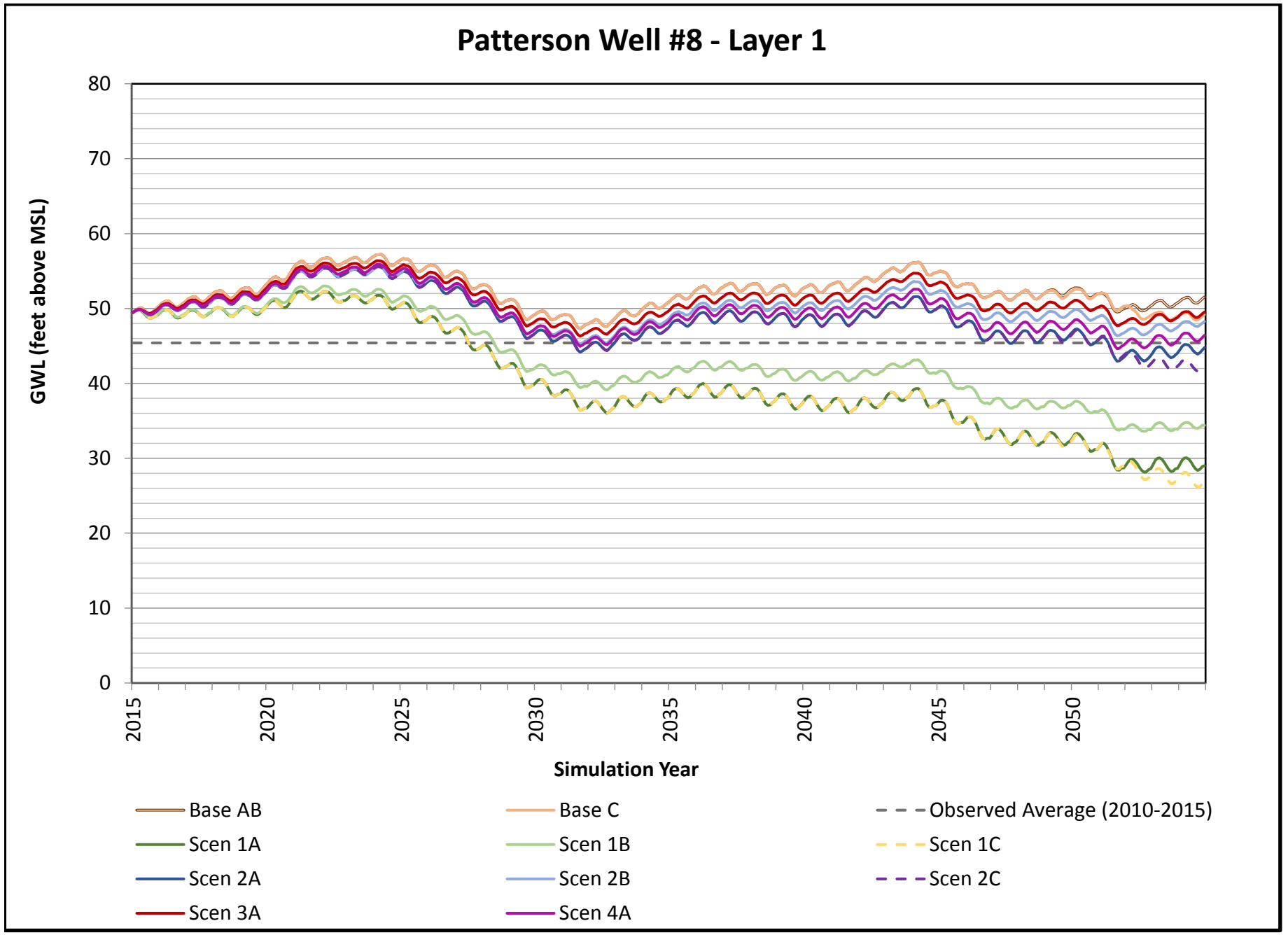

Patterson Well #6 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

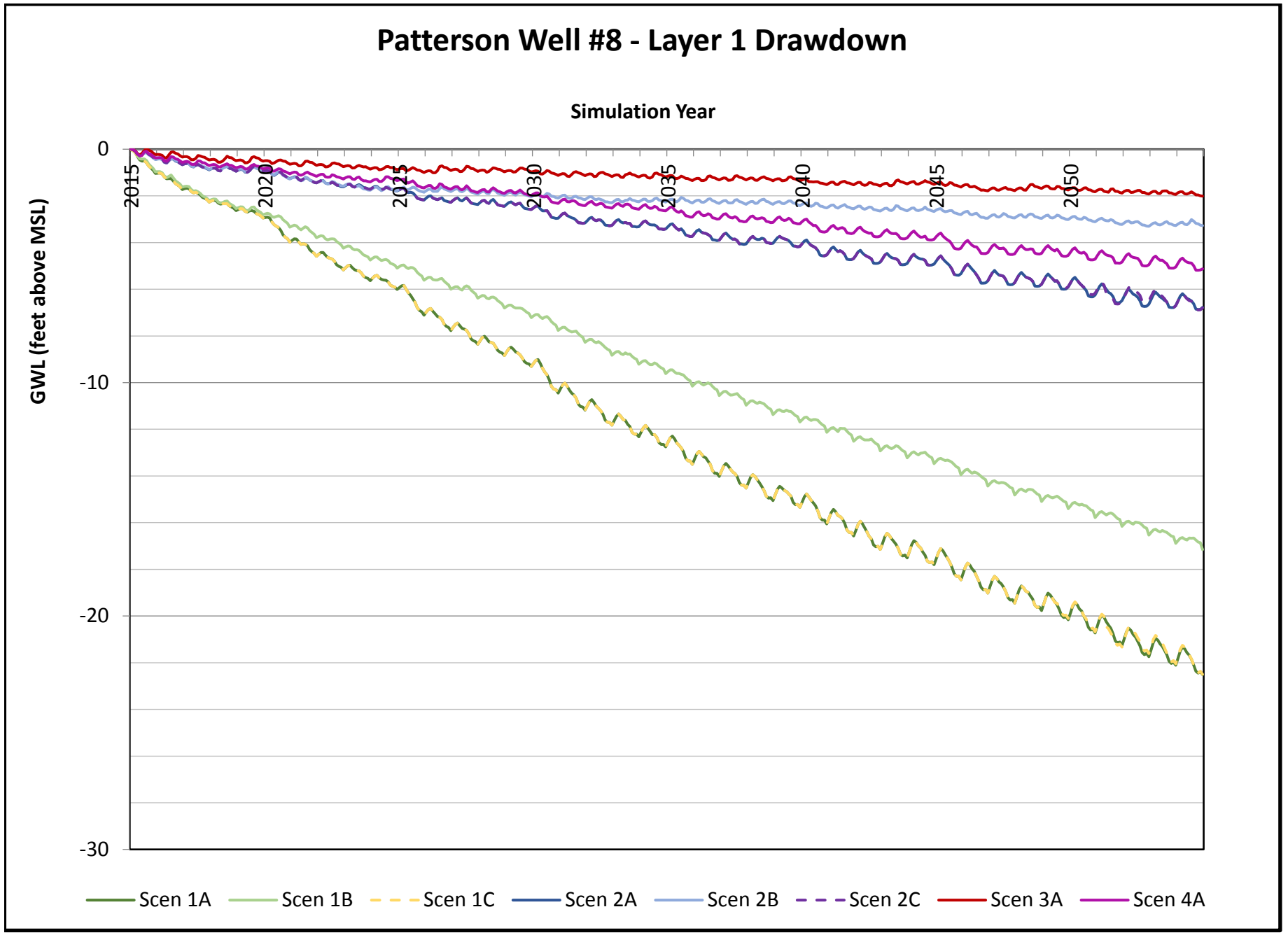

Patterson Well #7 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

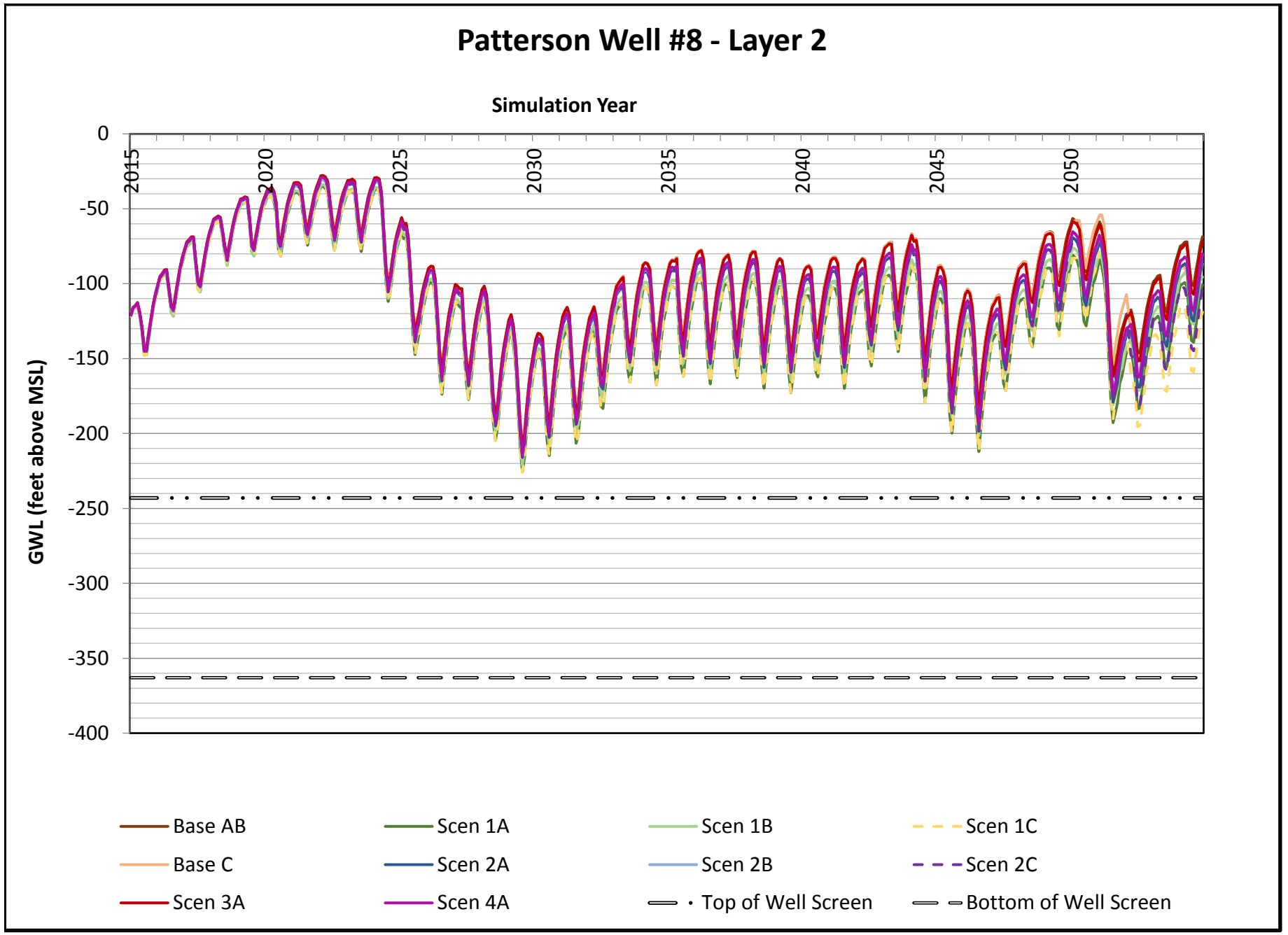

Patterson Well #7 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
-30
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

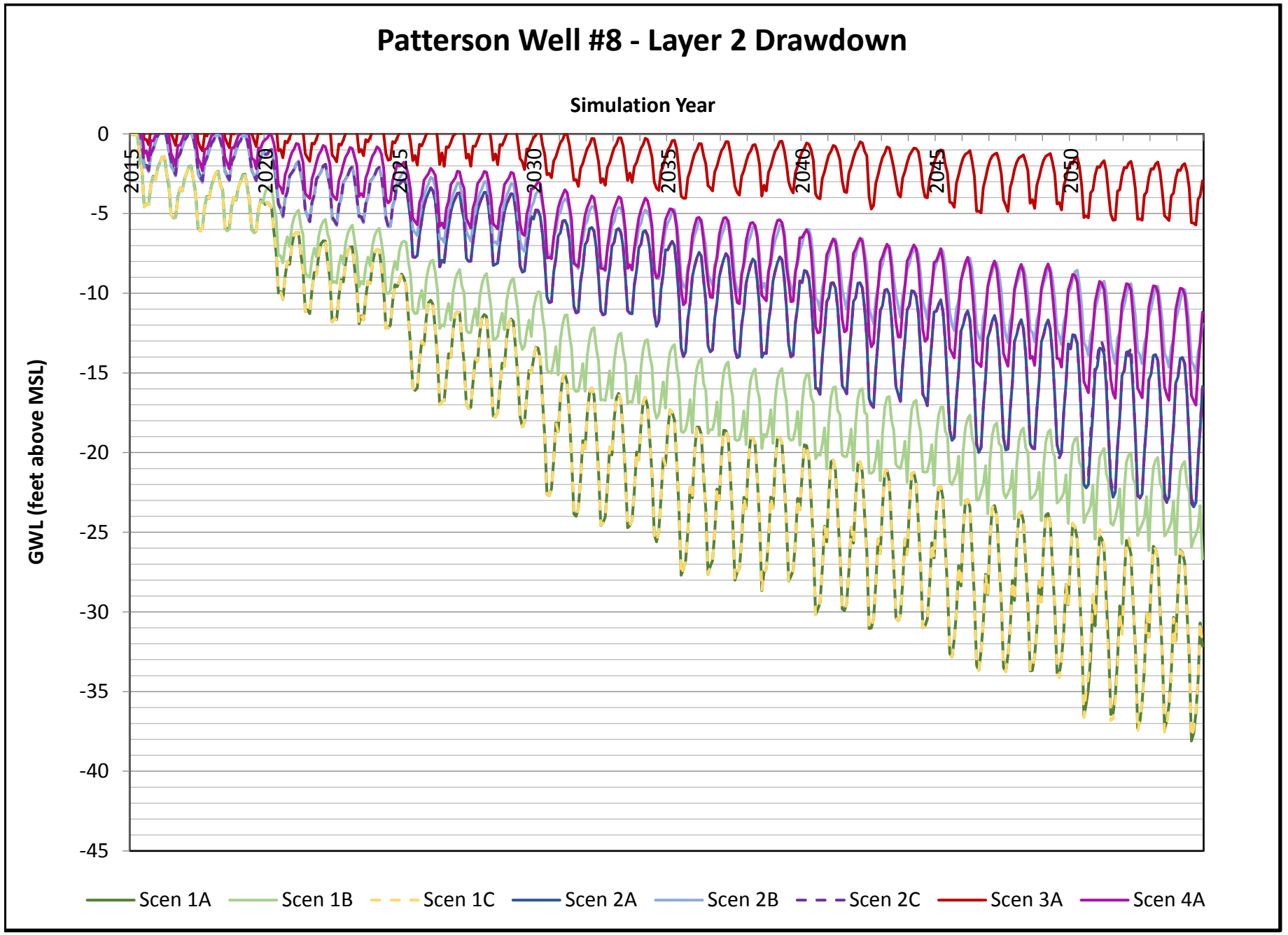

Patterson Well #7 - Layer 2
Simulation Year
GWL (feet above MSL)
0
-100
-200
-300
-400
-500
-600
2015
2020
2025
2030
2035
2040
2045
2050
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen

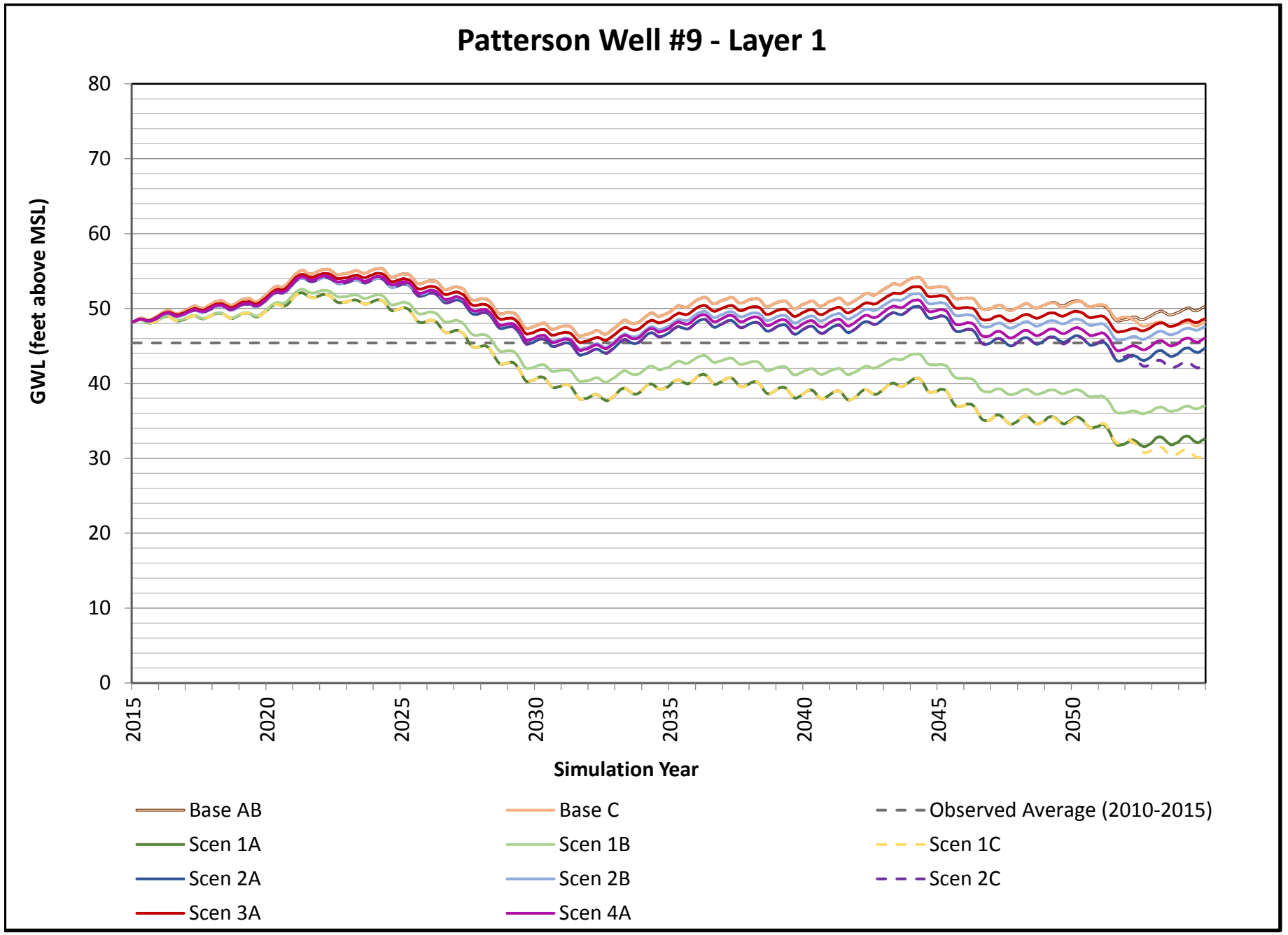

Patterson Well #7 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

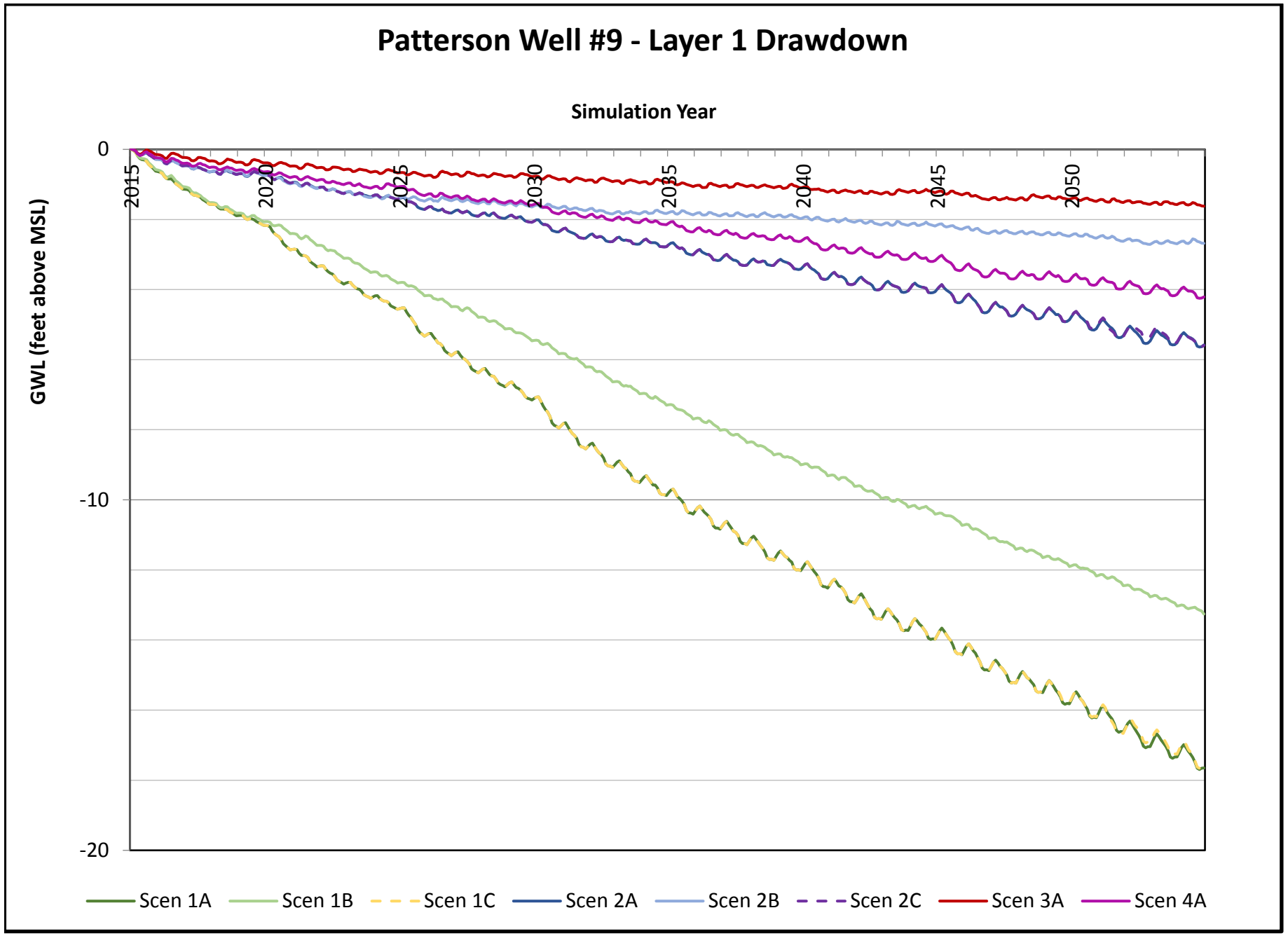

Patterson Well #8 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

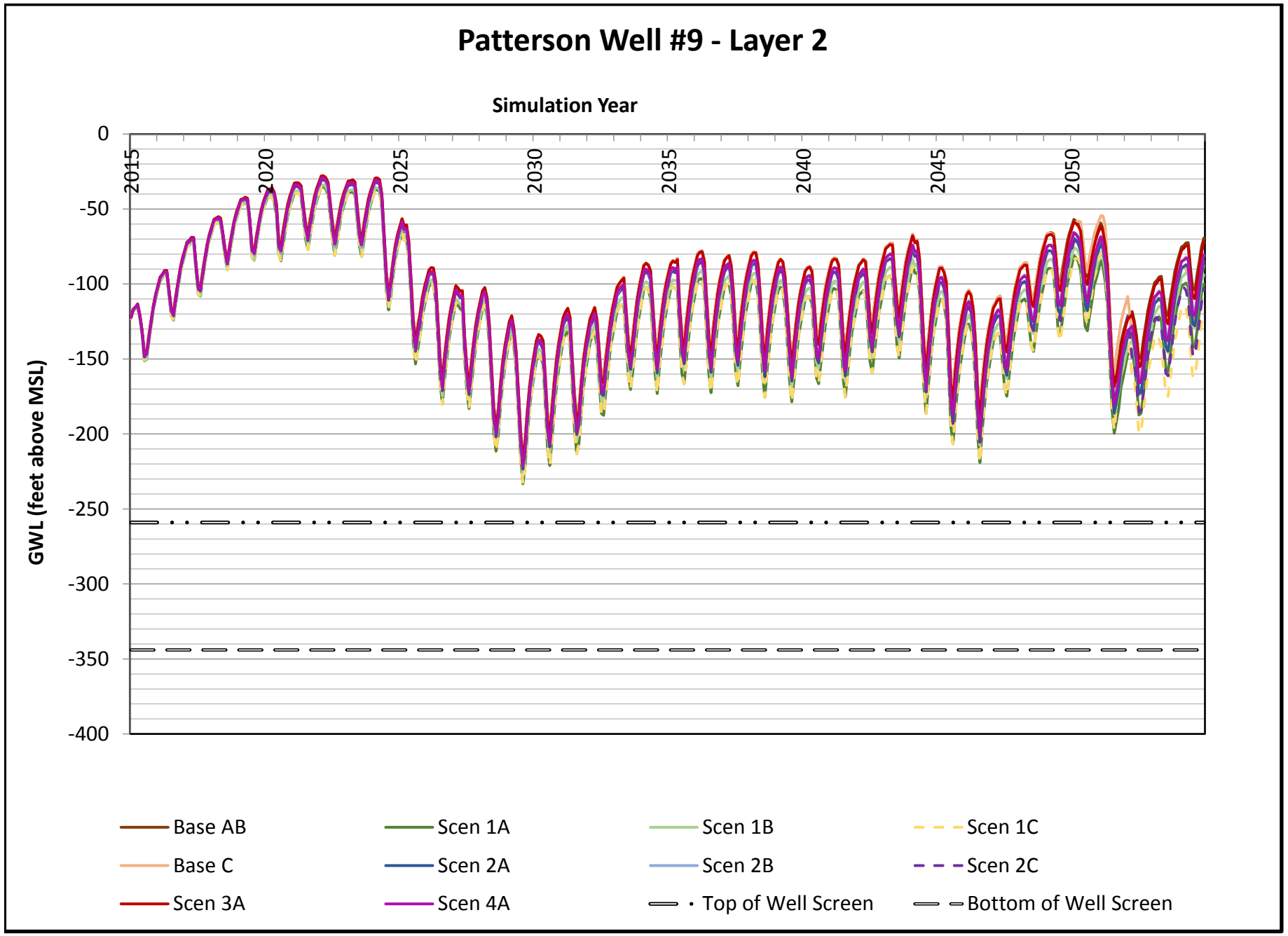

Patterson Well #8 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
-30
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

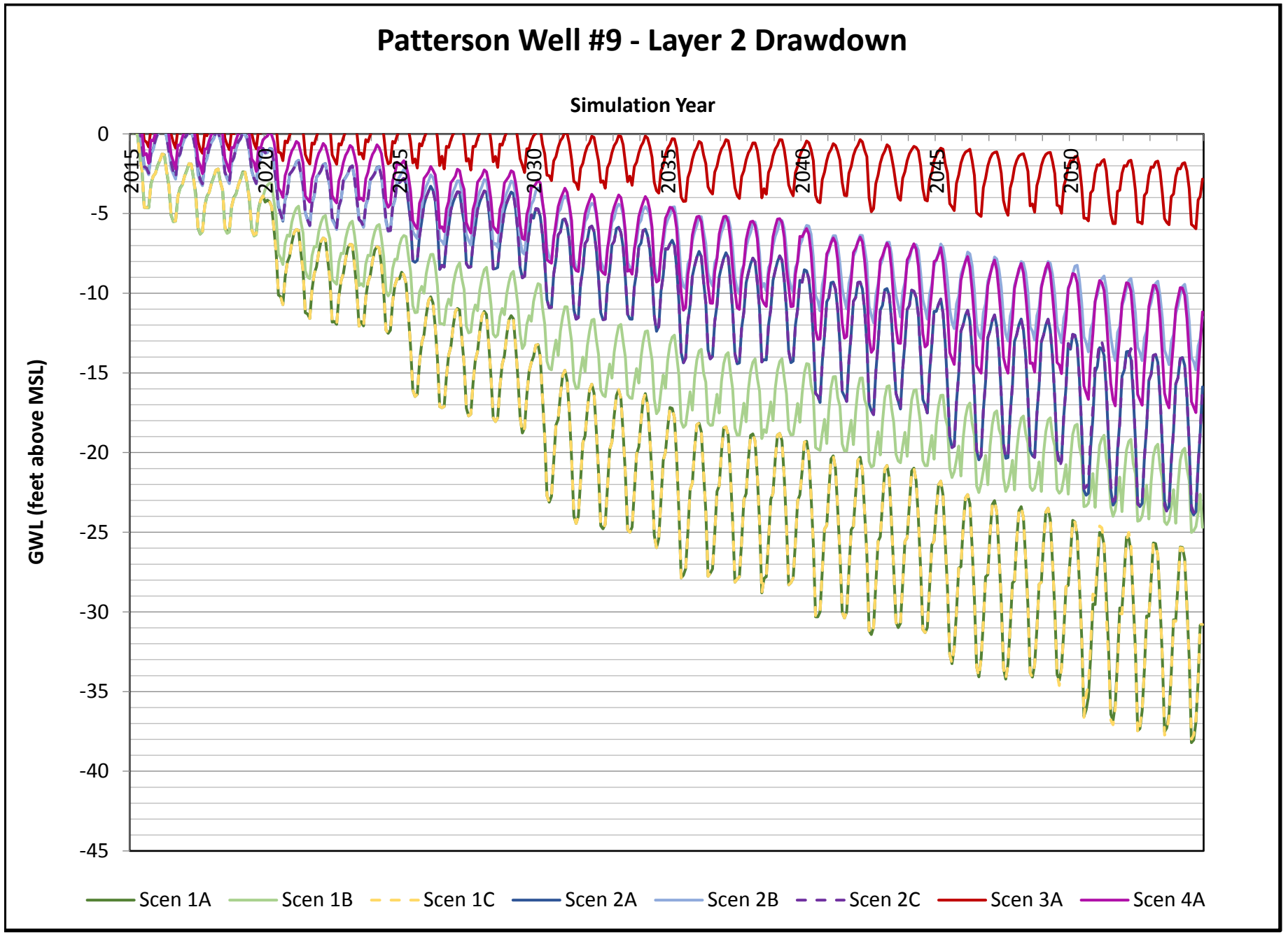

Patterson Well #8 - Layer 2
Simulation Year
GWL (feet above MSL)
0
-50
-100
-150
-200
-250
-300
-350
-400
2015
2020
2025
2030
2035
2040
2045
2050
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen

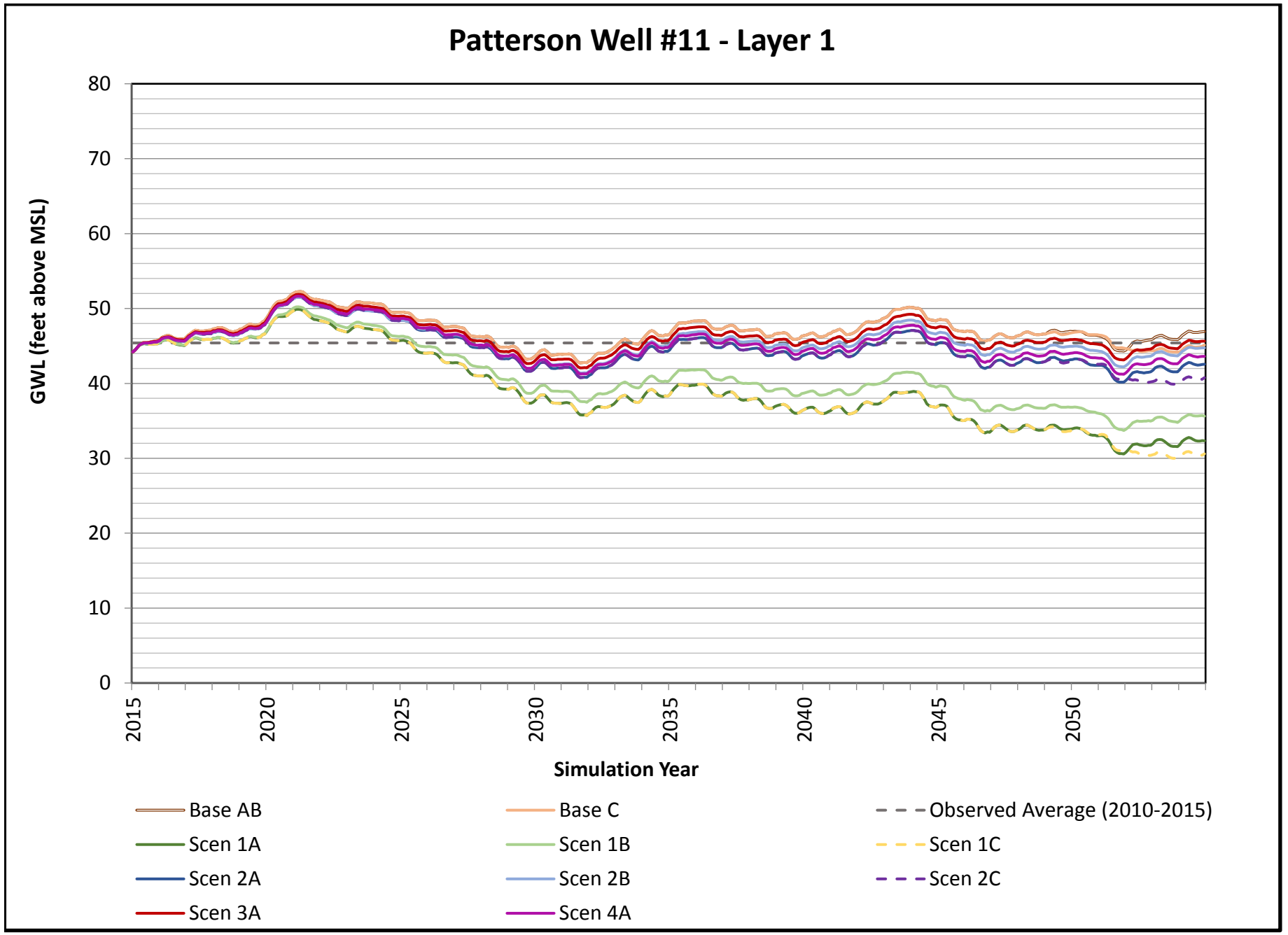

Patterson Well #8 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

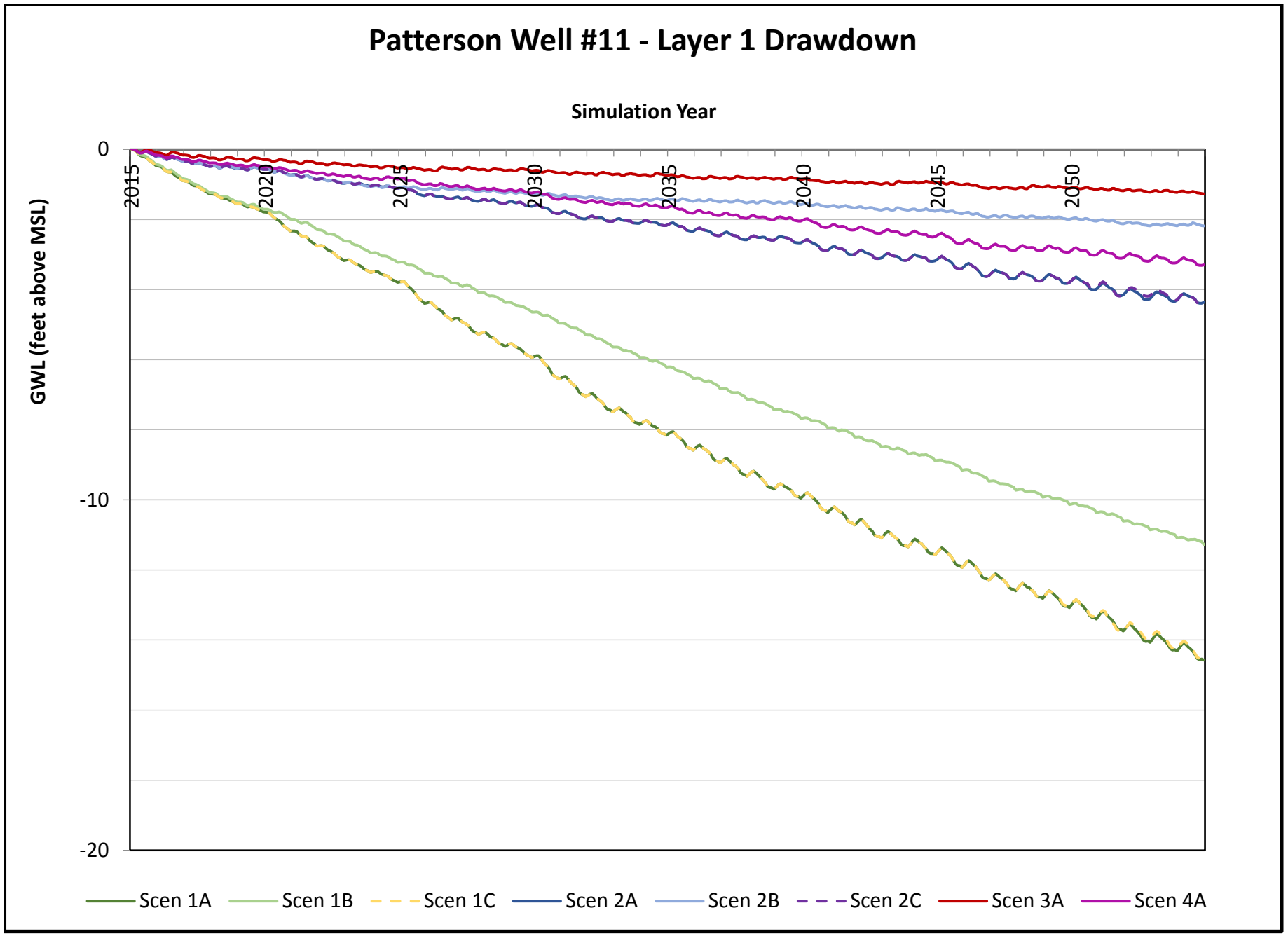

Patterson Well #9 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

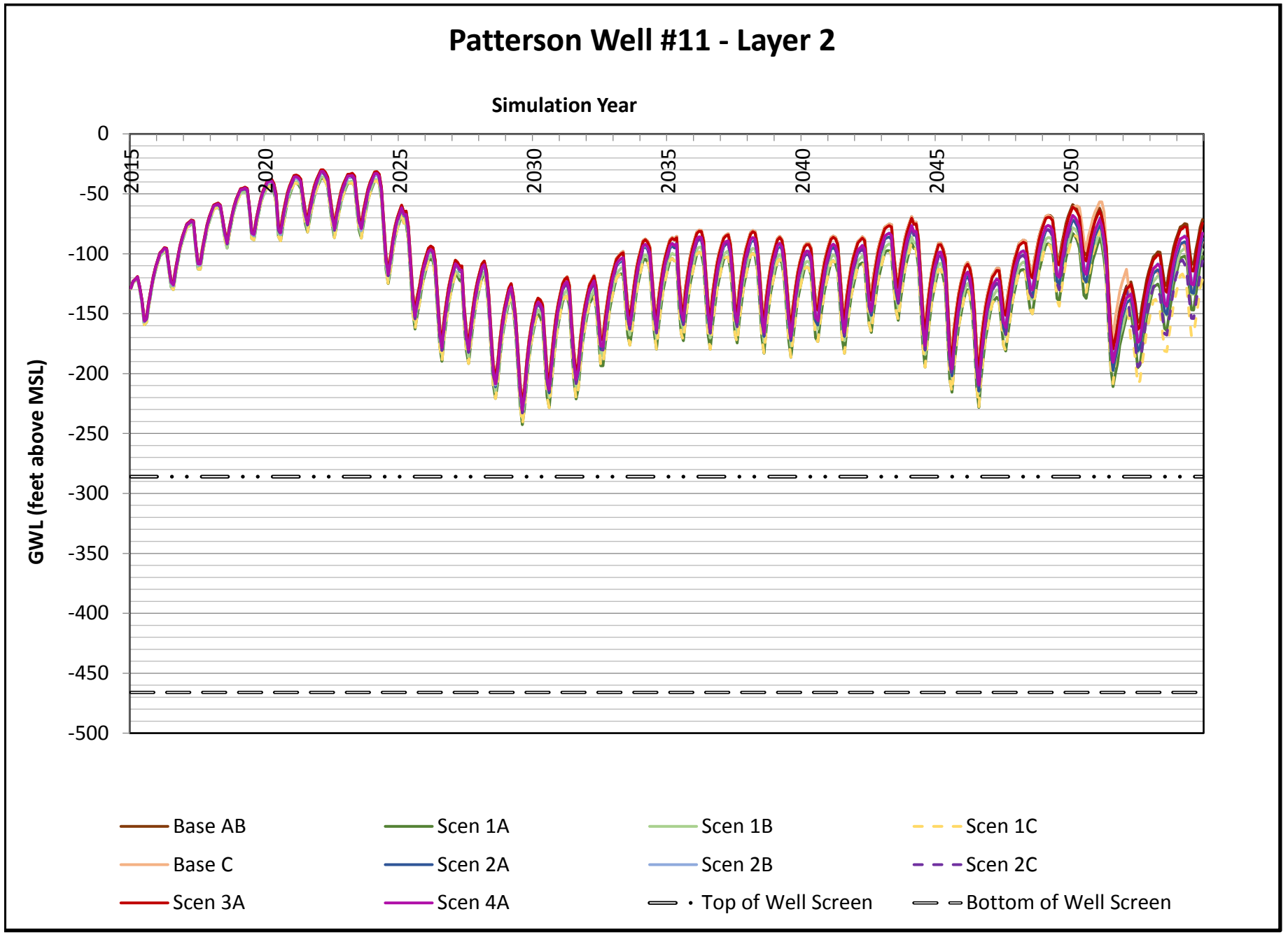

Patterson Well #9 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

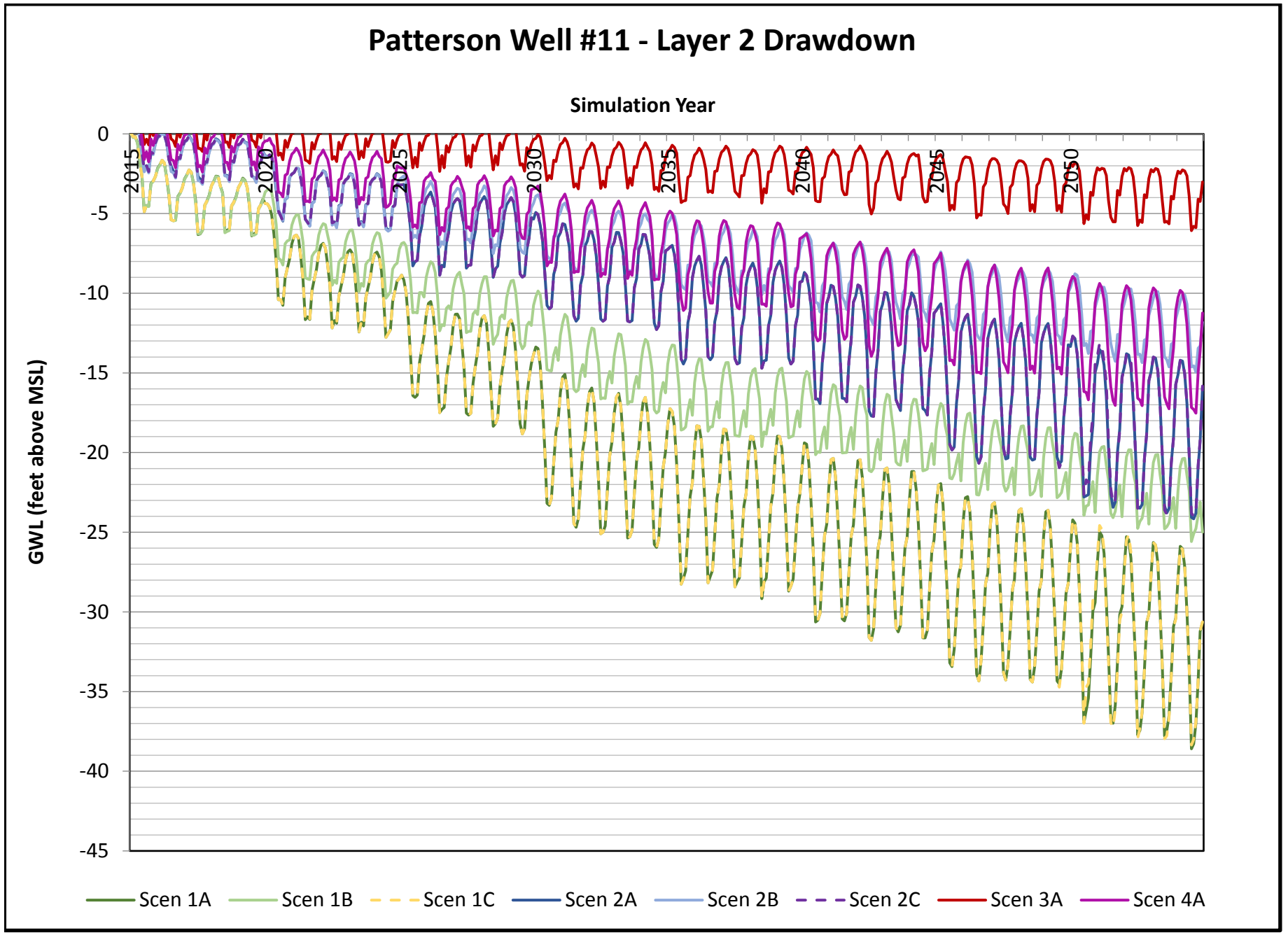

Patterson Well #9 - Layer 2
Simulation Year
GWL (feet above MSL)
0
-50
-100
-150
-200
-250
-300
-350
-400
2015
2020
2025
2030
2035
2040
2045
2050
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen


Patterson Well #9 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A


Patterson Well #11 - Layer 1
GWL (feet above MSL)
80
70
60
50
40
30
20
10
0
2015
2020
2025
2030
2035
2040
2045
2050
Simulation Year
Base AB
Base C
Observed Average (2010-2015)
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A


Patterson Well #11 - Layer 1 Drawdown
Simulation Year
GWL (feet above MSL)
0
-10
-20
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A


Patterson Well #11 - Layer 2
Simulation Year
GWL (feet above MSL)
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
2015
2020
2025
2030
2035
2040
2045
2050
Base AB
Scen 1A
Scen 1B
Scen 1C
Base C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A
Top of Well Screen
Bottom of Well Screen


Patterson Well #11 - Layer 2 Drawdown
Simulation Year
GWL (feet above MSL)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2015
2020
2025
2030
2035
2040
2045
2050
Scen 1A
Scen 1B
Scen 1C
Scen 2A
Scen 2B
Scen 2C
Scen 3A
Scen 4A

Appendix C - Ken Schmidt and Associates Hydrogeological Analysis

KENNETH D. SCHMIDT AND ASSOCIATES
GROUNDWATER QUALITY CONSULTANTS
600 WEST SHAW, SUITE 250
FRESNO, CALIFORNIA 93704
TELEPHONE (559) 224-4412

October 30, 2014

Mr. Ali Taghavi, Principal
RMC Water & Environment
1545 River Park Drive, Suite 425
Sacramento, CA 95815

Re: City of Patterson
Water Master Plan

Dear Ali,

Attached are copies of the following:

1. A map showing locations of wells and borings with information on shallow subsurface geologic conditions.
2. A map showing the locations of three subsurface geologic cross sections, extending to below the Corcoran Clay.
3. Three subsurface cross sections.

We expect to have the drafted map and cross sections within about ten days. Following are the results of this work, which is intended to provide information on the potential for intentional recharge in the Del Puerto Creek vicinity.

Shallow Conditions

Figure 1 shows locations of wells and borings with logs that provide information on the uppermost 50 feet or so of deposits. Deposits in this interval are considered the most important in terms of surficial material that may need to be excavated and potential restricting layers above the water table. An area is delineated which is considered favorable for intentional recharge. The favorable area apparently has less than about five feet of surficial material that would need to be excavated, and has a minimal amount of fine-grained deposits within the uppermost 50 feet. The area indicated to be favorable is largely in the south half of Section 15 of T5S/R7E. This area is primarily north of Zacharias Road, between Raines and Rogers Roads. The apparently favorable area extends to the southwest of the Delta Mendota Canal (DMC) near and south of Zacharias Road. In contrast, the apparently unfavorable area is underlain from 10 to 20 feet of fine-grained surficial material and/or fairly extensive clay layers above a depth of 50 feet.

Subsurface Geologic Cross Sections

Logs for wells and borings were used to develop three subsurface geologic cross sections (Figure 2). Cross Sections A-A′ and B-B′ extend from the southwest, near the California Aqueduct, to the northeast. These sections are aligned in the downslope direction along the Del Puerto Creek alluvial fan. Cross Section C-C′ is oriented generally perpendicular to the other sections, along the DMC. The sections were developed to extend below the Corcoran Clay. Two issues to be addressed are:

1. The extent of possible restricting layers above the water level and confining beds below the water level and above the Corcoran Clay.
2. The potential for recharge to the southwest that could benefit the lower aquifer (ie, bypass the Corcoran Clay).

In most of the logs evaluated in this area, the Corcoran Clay lacks its distinctive blue color, and is primarily brown. For this reason, this clay is referred to as the Corcoran Clay equivalent. Water producing strata and fine-grained deposits are shown on the cross sections. Regional information indicates that the Corcoran Clay thins to the southwest in the Patterson area. The clay pinches out somewhere east of the California Aqueduct.

Cross Section A-A′ (Figure 3) indicates that the top of the Corcoran Clay equivalent averages about 140 feet deep. The clay ranges from about 25 feet thick to the southwest to 40 feet thick near the northeast edge of the section. Coarse-grained stream channel deposits are predominant above the Corcoran Clay equivalent, and are also common below the clay. At most wells or borings, the uppermost five to ten feet of material is fine-grained. There are two sites (21G and 22D) where no fine-grained surficial materials were indicated. There appear to be no laterally extensive fine-grained deposits below the surficial materials and above the Corcoran Clay equivalent along the cross section. The southwest end of the section indicates that the Corcoran Clay equivalent is not present. Thus intentional recharge southwest of the DMC could benefit the lower aquifer.

Cross Section B-B′ (Figure 4) generally indicates similar conditions as Section A-A′. The top of the Corcoran Clay equivalent ranges from about 100 to 110 feet deep along the section. The clay also pinches out between the DMC and the Aqueduct. Deposits above the clay are primarily coarse-grained stream channel deposits in the area northeast of the DMC. Relatively thick, coarse-grained stream channel deposits are also present below the Corcoran Clay along the cross section. Southwest of the DMC, the coarse-grained deposits are divided by fine-grained deposits that

are present between about 40 and 90 feet in depth. More data is needed in this area between the Aqueduct and DMC to determine whether or not intentional recharge at or near the land surface could benefit the lower aquifer. No other laterally extensive fine-grained deposits are indicated above the Corcoran Clay equivalent along this section. Fine-grained surficial deposits are extensive along the section, and range in thickness from about five to ten feet. No fine-grained surficial deposits were indicated at the northwesternmost well (15B) along the section. Cross Section C-C′ (Figure 5) indicates that the top of the Corcoran Clay equivalent ranges from about 150 to 165 feet deep along the section. Coarse-grained stream channel deposits are predominant above the clay along the north half of the section. In contrast, near the south end of the section, coarse-grained deposits are of limited thickness, and fine-grained deposits are predominant. Fine-grained surficial materials are present along most of the cross section, and range in thickness from about five to twenty feet.

In summary, subsurface geologic conditions beneath much of the Del Puerto Creek alluvial fan are indicated to be favorable for intentional recharge. The next step is to do soil borings in the apparently favorable area to find sites where minimal excavation would be required, and where shallow restricting layers are not present that could hinder recharge. This will provide information on the location of where a pilot recharge test can be done. Attached is a map showing the locations of the proposed borings.

Please call me if you have any questions.

Sincerely yours,

K. Schmidt

Kenneth D. Schmidt

KDS/cl

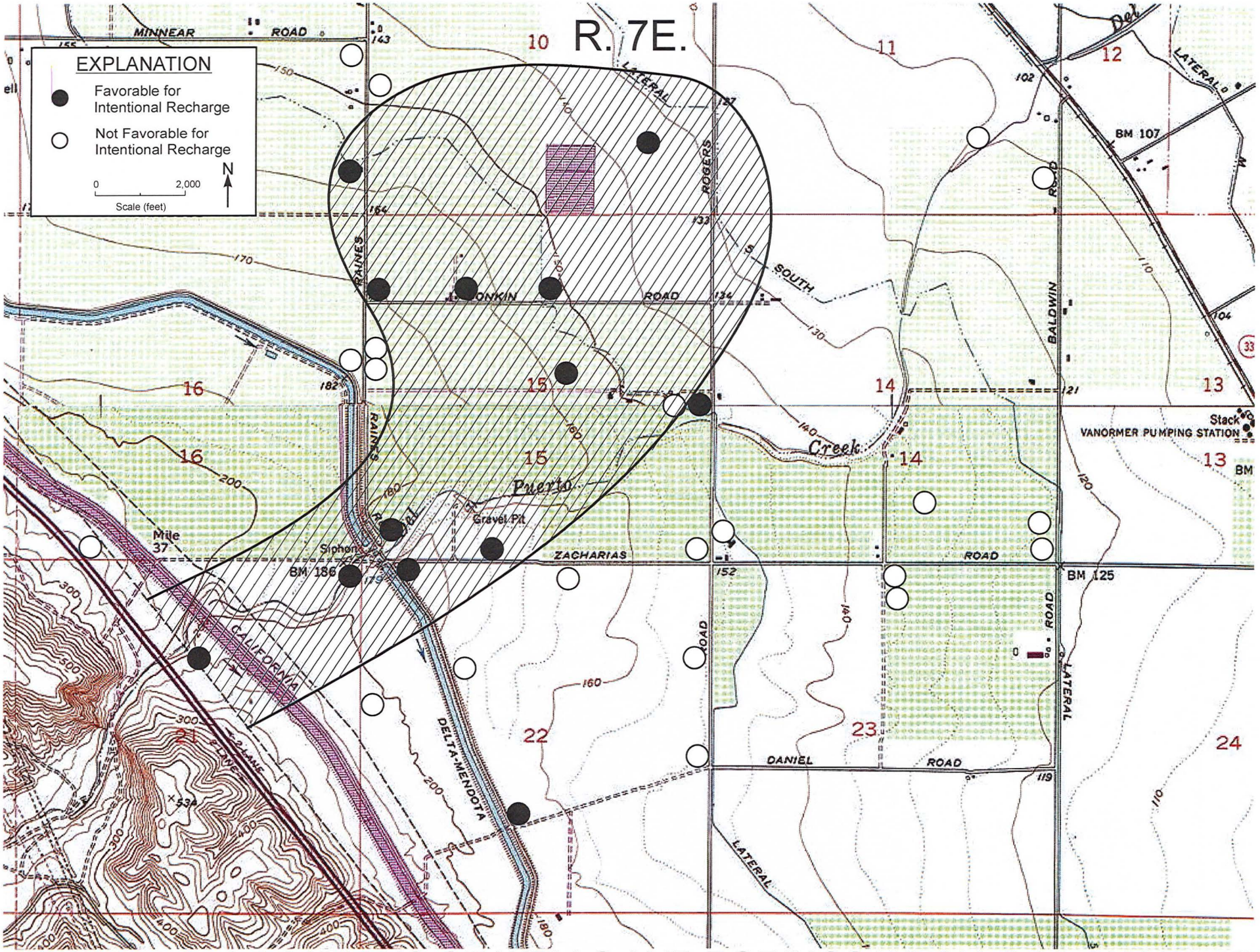


FIGURE 1 - LOCATIONS OF WELLS AND BORINGS WITH LOGS SHOWING SHALLOW CONDITIONS

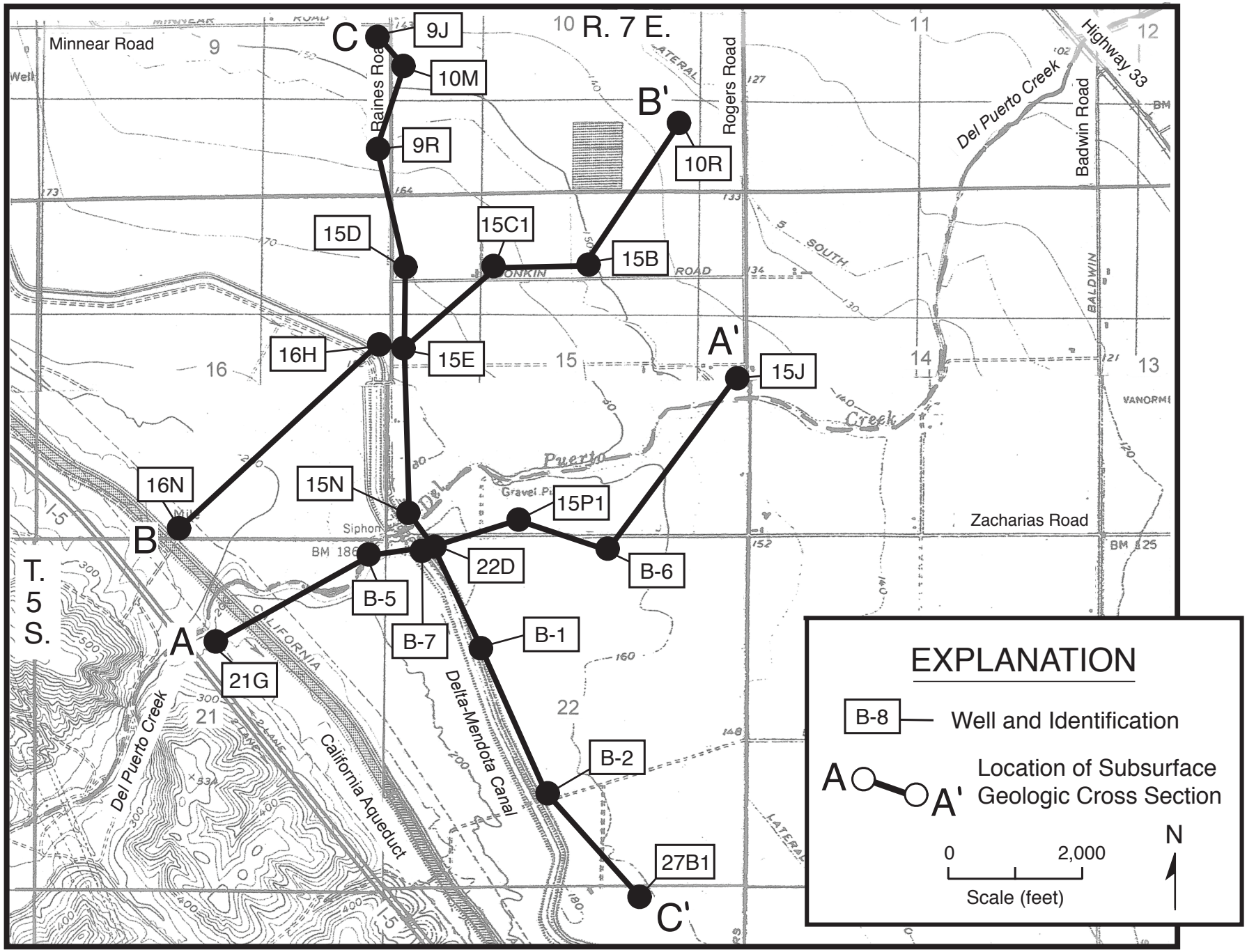


FIGURE 2 - LOCATION OF SELECTED WELLS, TEST HOLES AND SUBSURFACE GEOLOGIC CROSS SECTIONS

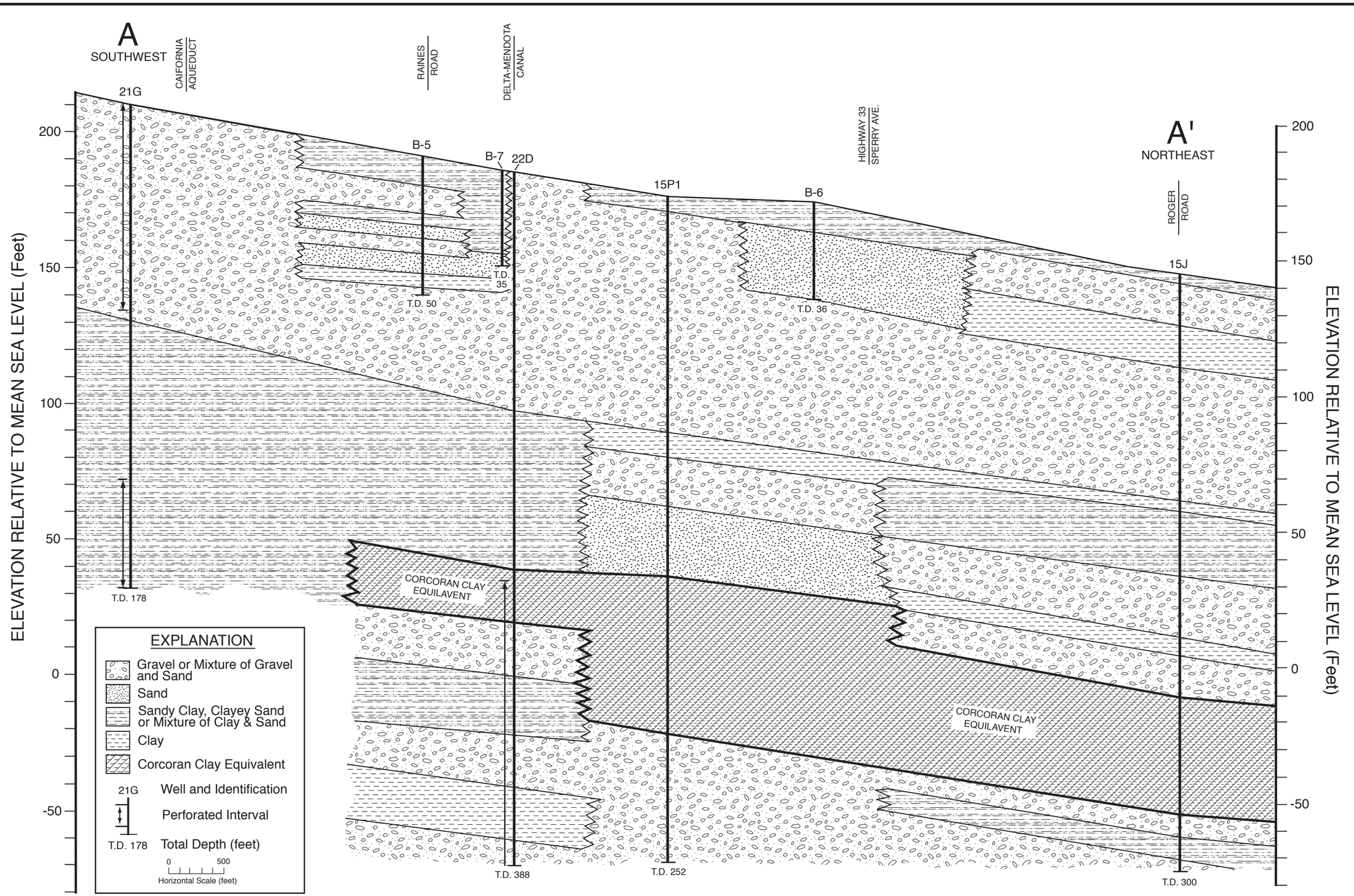


FIGURE 3 - SUBSURFACE GEOLOGIC CROSS SECTION A - A'

B
SOUTHWEST

B'
NORTHEAST

CAIFORNIA AQUEDUCT

DELTA-MENDOTA CANAL

RAINES ROAD

16N

16H

15E

15C1

15B

10R

ELEVATION RELATIVE TO MEAN SEA LEVEL (Feet)

200
150
100
50
0
-50
-100

CORCORAN CLAY EQUILAVENT

CORCORAN CLAY EQUILAVENT

T.D. 450

T.D. 252

T.D. 540

T.D. 300

T.D. 255

T.D. 520

EXPLANATION

- Gravel or Mixture of Gravel and Sand
- Sand
- Sandy Clay, Clayey Sand and Mixture of Sand & Clay
- Clay
- Corcoran Clay Equivalent

16H — Well and Identification

Perforated Interval

T.D. 252 — Total Depth (feet)

0 500
Horizontal Scale (feet)

FIGURE 4 - SUBSURFACE GEOLOGIC CROSS SECTION B - B'

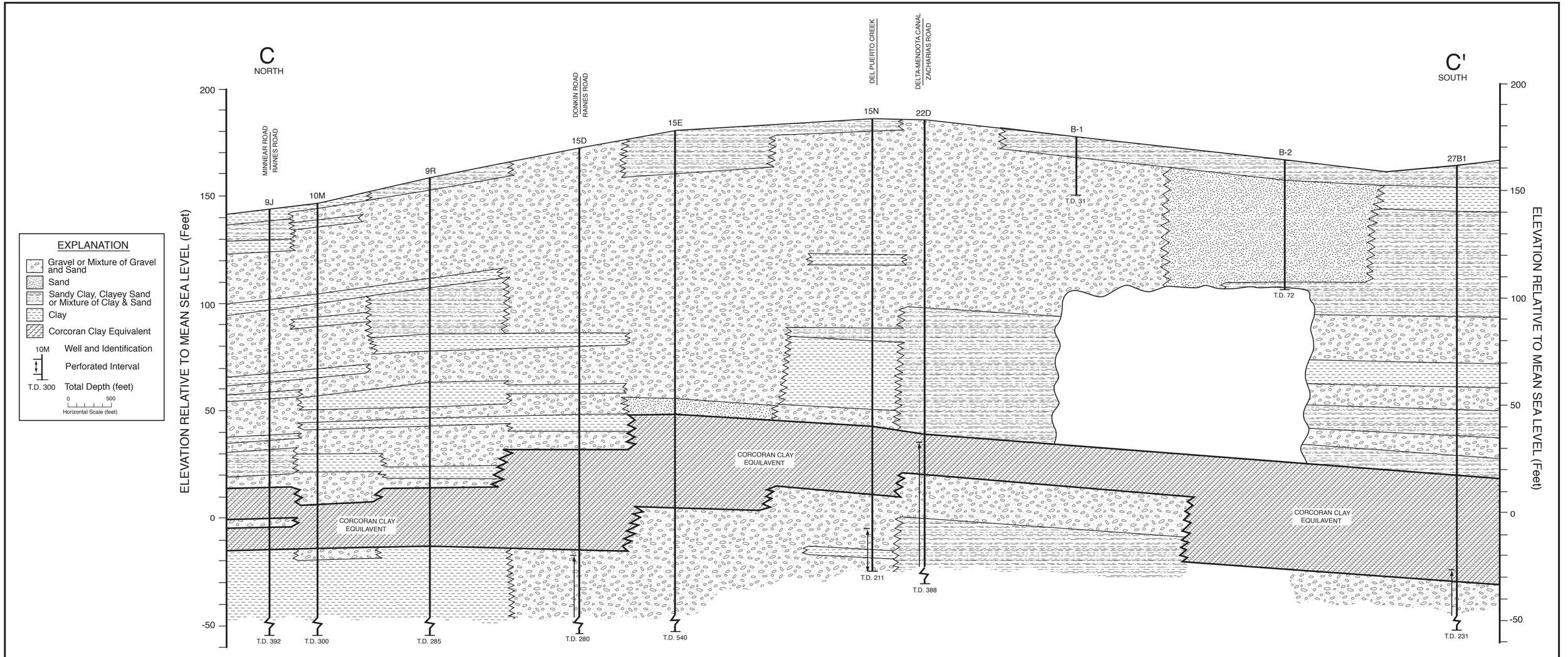


FIGURE 5 - SUBSURFACE GEOLOGIC CROSS SECTION C - C'

Appendix D - Groundwater Boring Fieldwork Reports

June 11, 2015 TES No. 150340.001

Ms. Sarah Rhodes
RMC Water and Environment
2175 North California Boulevard, Suite 315
Walnut Creek, California

SUBJECT: Drilling and Soil Logging Services

PROJECT: Patterson Field Program
Zacharias Road and Delta-Mendota Canal
Patterson, California

Dear Ms. Rhodes:

In accordance with your request and authorization, **TECHNICON Engineering Services, Inc. (TECHNICON)** drilled two (2) borings and soil logging services at the above referenced site located in Patterson, California. The attached Site Map, Figure 1, provides the location of site and the Site Map, Figure 2, provides the locations of the test borings for this study.

PROJECT BACKROUND INFROMATION

The subsurface soil stratigraphy is desired at fifteen (15) locations near the intersection of Zacharias Road and the Delta-Mendota Canal. Based on conversations and a site plan and coordinates which indicated the requested locations of the borings. The test borings are being performed in order to detect dense or fine grain clay and silt layers below the ground surface that may impede groundwater recharge.

FIELD EXPLORATION

The field exploration, conducted from June 1st to 5th, 2015, consisted of drilling three (3) of the total fifteen (15) exploratory test borings and a site reconnaissance by a staff engineer. The test borings were drilled with a CME 55 truck-mounted drill rig using hollow stem augers, mud rotary, and concentric drilling techniques. The attached drill rigs dimensions provides the measurements and typical capabilities of the CME 55 drill rig. Boring B-3 was drilled to the requested depth of 50 feet below ground surface (bgs). Borings B-1 and B-2 were drilled to auger refusal at depths 102 and 22 feet bgs, respectively. Borings B-1 and B-3 were cement grouted and B-2 was back filled with soil cuttings.

The soils encountered in the borings were visually classified in the field and a continuous log was recorded in general accordance with ASTM D2487. Samples of the subsurface material were obtained using a 1.4-inch I.D. standard penetrometer, driven 18 inches in accordance with ASTM D1586 test procedures. The soil samples were stored in plastic bags and labeled with the boring number and depth. The sampler was used without liners. Resistance to sampler penetration was noted as the number of blows per foot over the last 12 inches of sampler

penetration on the boring logs. The blow counts listed in the boring logs have not been corrected for the effects of overburden pressure, boring diameter, rod length, sampler size, or hammer efficiency.

EARTH MATERIALS

The general earth material profile depicted by the subsurface exploration consisted of clayey sand with gravel, sandy clay with gravel, sandy gravel with cobbles, sandy cobbles, silty sand with some gravel and cobbles, clayey gravel with cobbles and gravelly cobble with clay extending to the depth explored 102 feet bgs. The subgrade conditions were generally medium to very dense. A more detailed representation of the stratigraphy at the specific exploration locations is provided on the attached boring logs. Groundwater was not encountered within the depth of exploration, 102 feet bgs.

CLOSING

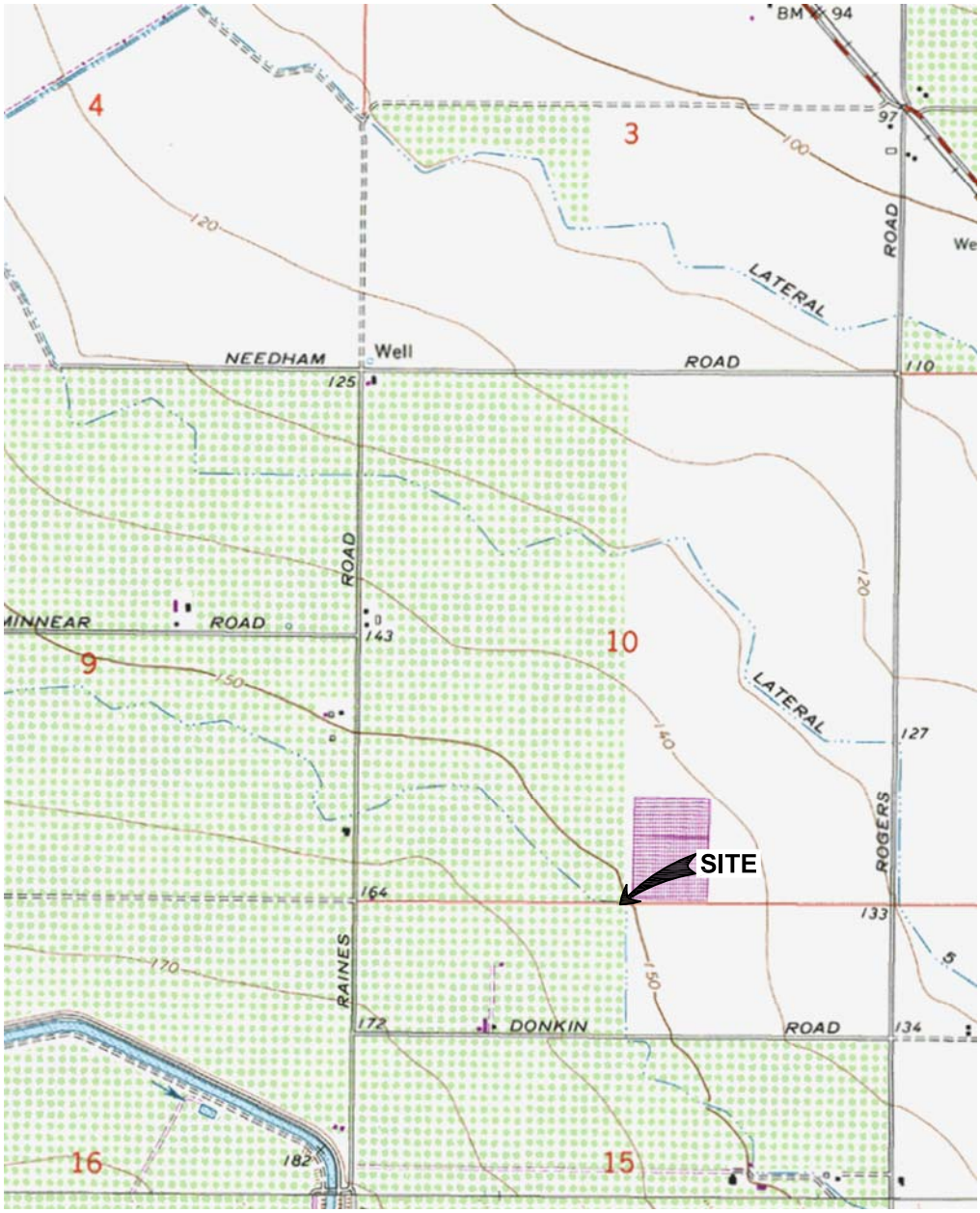
If you have any questions regarding the information presented, please contact us at your convenience.

Sincerely,
TECHNICON Engineering Services, Inc.

Stephen P. Plauson, PE, GE
Geotechnical Engineering Manager

SS:SPP:lc

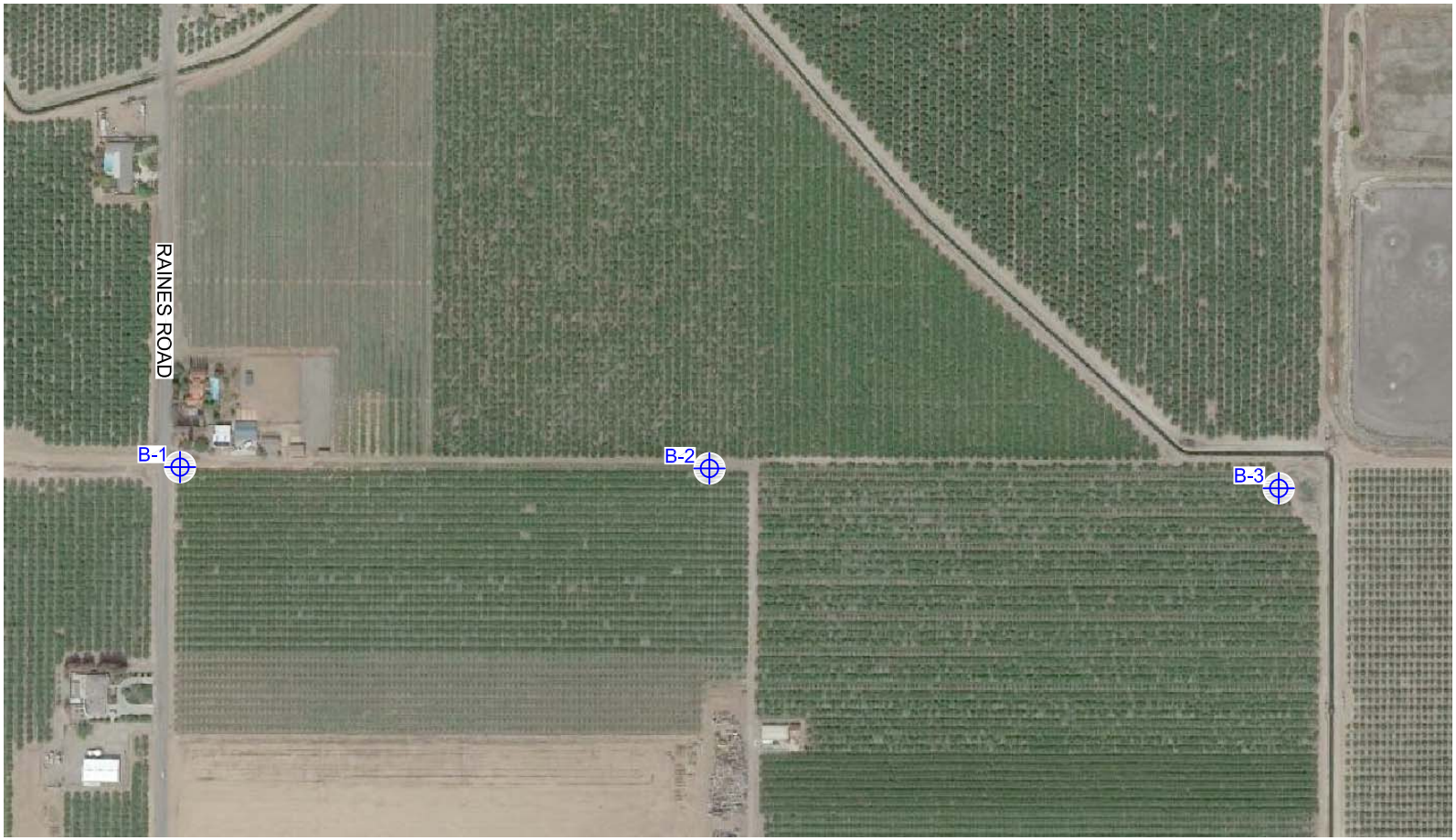
Attachments: Vicinity Map, Figure 1
Site Map, Figure 2
Drill Rigs Dimensions
Key to Symbols and Boring Logs



N

LAT.: 37.5078°N, LONG.: 121.1908°W, 15-T5S-R7E, MDB&M, USGS MAP: WESTLEY, DATE: 1991

TECHNICON ENGINEERING SERVICES, INC.	PROJECT: 150340 SOURCE: USGS TOPOGRAPHIC MAPS	VICINITY MAP PATTERSON FIELD PROGRAM NE OF RAINES AND DONKIN ROADS PATTERSON, CALIFORNIA	FIGURE 1 NTS



N

SCALE: 1"=400'

0' 200' 400'

B-3 =SOIL BORING LOCATIONS

TECHNICON
ENGINEERING SERVICES, INC.

PROJECT: 150340	DATE: 6/10/15	SITE MAP PATTERSON FIELD PROGRAM NE OF RAINES AND DONKIN ROADS PATTERSON, CALIFORNIA	FIGURE 2
SOURCE: GOOGLE EARTH	APPROVED BY: RC		

Drill Rigs	CME-45 4x4	CME-55 4x4	CME-55
Length	24'	27' 6"	24'
Width	9’	9' 6"	9' 6"
Height (Mast Down)	11’	11' 6"	10' 8"
Height (Mast Up)	30'	13’ to 37'	36'
Maximum Soil Boring Depth	70' Auger	160' Auger 250' Rotary-Wash	160' Auger 80' Rotary-Wash
Maximum Monitor Well Depth	60'	160'	160'
Casing Diameter	1” & 2"	1”, 2", 3” & 4"	1”, 2", 3”, & 4"
Monitoring Well Types	Water & Vapor	Water & Vapor	Water & Vapor
Maximum Drilling Angle	45º	45º	N/A
Rotary-Wash Capable	N/A	Yes	Yes
Auger & Rod Types	7.5" HSA, 9" HSA, & 4" Straight Flight	7.5" HSA, 9"HSA, 12" HSA, 4"Straight Flight, & AWJ Rod	7.5" HSA, 9"HSA, 12" HAS, 4"Straight Flight, NWJ Rod, HQ3 wire line rock coring, & AWJ Rod
Samplers	California, Modified California, & SPT	California, Modified California, SPT, & 5’ continuous sampler	California, Modified California, SPT, 5’ Continuous Sampler, & HQ3 Coring

Technicon Engineering Services, INC.
4539 N Brawley Ave. #108
Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

KEY TO SYMBOLS

PROJECT NAME Patterson Field Program
DATE OF EXPLORATION 6/1/2015
PROJECT LOCATION Patterson, CA
PROJECT NUMBER 150340

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

		FILL
	SW	WELL GRADED SAND
	SP	POORLY GRADED SAND
	SM	SILTY SAND
	SC	CLAYEY SAND
	PT	PEAT
	OL	LOW PLASTICITY ORGANIC SILT
	OH	HIGH PLASTICITY ORGANIC SILT
	ML	LOW PLASTICITY SILT
	MH	HIGH PLASTICITY SILT
	GW	WELL GRADED GRAVEL
	GP	POORLY GRADED GRAVEL
	GM	SILTY GRAVEL
	GC	CLAYEY GRAVEL
	CL	LOW PLASTICITY CLAY
	CH	HIGH PLASTICITY CLAY

SAMPLER SYMBOLS

STANDARD PENETRATION TEST

CALIFORNIA SAMPLER

MODIFIED CALIFORNIA SAMPLER

SHELBY TUBE SAMPLER

ROCK CORE BARREL

BULK SAMPLE

Water Level at Time of Drilling

Water Level at End of Drilling

Water Level After 24 Hours

Assumed stratum line

Observed stratum line

Note 1: The degree of saturation shown on the boring logs is based on an assumed specific gravity of 2.65. The actual degree of saturation may vary.

Note 2: The stratum lines shown on the logs represent the approximate boundary between soil types; the actual in-situ transition may be gradual.

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
S - DEGREE OF SATURATION (%)
NP - NON PLASTIC
-200 PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION

KEY TO SYMBOLS 2 - TECHNICON.GDT - 6/11/15 15:08 - \\TECH1\USERSHARES\TESDATA\USERS\SARBS\REPORTS\PATTERSON\150340- PATTERSON FIELD PROGRAM\150340.GPJ

Technicon Engineering Services, INC.
4539 N Brawley Ave. #108
Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-1

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/1/15 **COMPLETED** 6/3/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 102 ft
DRILLING METHOD Hollow Stem Auger, Mud Rotary, Concentric Drilling **LOGGED BY** S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	GB			**Clayey SAND (SC)** - dense, light brown, moist, fine to coarse grained, with gravel				
5				**Sandy CLAY (CL)** - brown, moist, low plasticity, some gravel				
	SPT	19-31-15 (46)		**Sandy GRAVEL (GP-GM)** - very dense, grayish brown, moist, medium to coarse grained, some cobbles				
10				**Poorly Graded GRAVEL (GP)** - dense, brown, moist, medium to coarse grained, some cobbles				
	SPT	12-18-19 (37)						
15	SPT	50						
				Sandy COBBLE blackish brown, rounded to angular cobble with gravel and some silts, moist, very dense				
20	SPT	31-50/4"		Trace clay				
25	SPT	25-50		Trace clay				
30	SPT	31-40-30 (70)		Trace clay				
35								

(Continued Next Page)

BOREHOLE - TECHNICON.GDT - 6/11/15 15:08 - \\TECH1\USERSHARES\TESDATA\USERS\SARBS\REPORTS\PATTERSON\150340- PATTERSON FIELD PROGRAM\150340.GPJ

Technicon Engineering Services, INC.
4539 N Brawley Ave. #108
Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-1

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/1/15 **COMPLETED** 6/3/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 102 ft
DRILLING METHOD Hollow Stem Auger, Mud Rotary, Concentric Drilling **LOGGED BY** S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
35	SPT	11-31-38 (69)		**Sandy COBBLE** blackish brown, rounded to angular cobble with gravel and some silts, moist, very dense *(continued)*				
40	SPT	9-15-16 (31)		**Silty SAND (SM)** - medium dense, brown, moist, fine to coarse grained, some gravel, some cobbles, some clay				
				Sandy CLAY (CL) - brown, moist, high plasticity				
45	SPT	18-28-25 (53)		**Clayey SAND (SC)** - very dense, brown, moist, fine to coarse grained, with gravel, with cobbles				
50	SPT	49-50/5"		**Clayey GRAVEL (GC)** - very dense, grayish brown, moist, fine to coarse grained, with cobbles				
55	SPT	50/5"						
60	SPT	28-50/5"						
65	SPT	38-50		**Sandy COBBLE** reddish brown, rounded to angular cobble with gravel and trace of clay, moist, very dense				
70								

(Continued Next Page)

Technicon Engineering Services, INC.
4539 N Brawley Ave. #108
Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-1

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/1/15 **COMPLETED** 6/3/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 102 ft
DRILLING METHOD Hollow Stem Auger, Mud Rotary, Concentric Drilling **LOGGED BY** S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
70	SPT	50/3"		**Sandy COBBLE** reddish brown, rounded to angular cobble with gravel and trace of clay, moist, very dense *(continued)* Brownish black				
				Sandy CLAY (CL) - brown, moist				
75	SPT	22-27-50 (77)		**Clayey GRAVEL (GC)** - very dense, reddish brown, moist, fine to coarse grained, with cobbles				
80	SPT	50		**Sandy COBBLE** blackish brown, rounded to angular cobble with gravel and clay, moist, very dense				
85	SPT	50/2"						
90	SPT	50/3"						
95	SPT	50/1"						
100	SPT	50/3"						

NOTES:
1. Bottom of boring at 102.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 6/3/15.

Technicon Engineering Services, INC.
4539 N Brawley Ave. #108
Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-2

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/5/15 **COMPLETED** 6/5/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 22 ft
DRILLING METHOD 7.5-inch Hollow Stem Auger
LOGGED BY S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	GB			**Clayey SAND (SC)** - dense, black, moist, fine to coarse grained, with gravel				
5				**Clayey GRAVEL (GC)** - dense, grayish brown, moist, medium to coarse grained, some cobbles				
	SPT	8-12-19 (31)						
10	SPT	11-19-22 (41)						
15	SPT	11-18-22 (40)						
20	SPT	36-50		**Sandy COBBLE** blackish brown, rounded to angular cobble with gravel and clay, moist, very dense				Auger Refusal

NOTES:
1. Bottom of boring at 22.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 6/5/15.

BOREHOLE - TECHNICON.GDT - 6/11/15 15:08 - \\TECH1\USERSHARES\TESDATA\USERS\SARBS\REPORTS\PATTERSON\150340- PATTERSON FIELD PROGRAM\150340.GPJ

Technicon Engineering Services, INC.
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Fresno, CA 93722
Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-3

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/4/15 **COMPLETED** 6/5/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 50 ft
DRILLING METHOD Concentric Drilling
LOGGED BY S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
0	GB			**Sandy CLAY (CL)** - medium dense, brown, moist, low plasticity, with gravel, some cobbles				
	SPT	11-13-14 (27)		**Sandy GRAVEL (GC)** - medium dense, brown, moist, medium to coarse grained, some cobbles				
5								
	SPT	13-15-15 (30)						
10				**Sandy CLAY (CL)** - medium dense, brown, moist, low plasticity, some gravel				
				Gravelly CLAY (CL) - dense, dark brown, moist				
	SPT	17-23-24 (47)		**Clayey GRAVEL (GC)** - dense, blackish brown, moist, fine to coarse grained, some cobbles				
15								
				Sandy GRAVEL (GP-GM) - dense, brown, moist, fine to coarse grained, some cobbles				
	SPT	15-20-24 (44)						
20								
				Sandy SILT (ML) - medium dense, brown, moist, trace clay				
	SPT	8-6-6 (12)						
25								
				Sandy GRAVEL (GP-GM) - very dense, blackish brown, moist, medium to coarse grained, some cobbles				
	SPT	33-50						
30				With cobbles				
	SPT	21-50/5"						
35								

(Continued Next Page)

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Telephone: (559) 2769311
Fax: (559) 2769344

BORING B-3

PROJECT NAME Patterson Field Program
PROJECT NUMBER 150340
PROJECT LOCATION Patterson, CA
SURFACE DESCRIPTION Flat Farm Drit Path
DATE STARTED 6/4/15 **COMPLETED** 6/5/15
GROUND ELEVATION
DRILLING CONTRACTOR TECHNICON Engineering Services
GROUND WATER LEVEL No groundwater encountered.
DRILL RIG TYPE CME-55
BORING DEPTH 50 ft
DRILLING METHOD Concentric Drilling
LOGGED BY S. Athwal **CHECKED BY** S. Plauson

DEPTH (ft)	SAMPLE TYPE	BLOWS/ft	GRAPHIC LOG	MATERIAL DESCRIPTION	DRY DENSITY (pcf)	MOISTURE (%)	OTHER TESTS	REMARKS
35								
				Sandy CLAY (CL) - medium dense, brown, moist, with gravel				
	SPT	6-9-18 (27)						
40				**Sandy GRAVEL (GP)** - dense, grayish brown, moist, medium to coarse grained, some cobbles				
	SPT	21-26-17 (43)						
45								
	SPT	34-50		Very dense, with cobbles				
50								

NOTES:
1. Bottom of boring at 50.0 feet.
2. No groundwater encountered.
3. Boring backfilled with soil cuttings 6/5/15.

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services
Sacramento | Modesto | Pleasanton | Rocklin | Ukiah

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Modesto: 1165 Scenic Drive, Suite B | Modesto, CA 95350 | (209) 312-7668
Pleasanton: 6200 Stoneridge Mall Road, Suite 330 | Pleasanton, CA 94588 | (925) 401-3515
Rocklin: 4220 Rocklin Road, Suite 1 | Rocklin, CA 95677 | (916) 455-4225
Ukiah: 100 North Pine Street | Ukiah, CA 95482| (707) 240-4400

July 27, 2017

Ian Jaffe, P.E.
Environmental Engineer
RMC, a Woodard & Curran Company
2175 North California Blvd, Suite 315
Walnut Creek, CA 94596

Subject: **SOIL LOGGING MEMORANDUM**
Patterson Groundwater Recharge Project
Patterson, CA

Mr. Jaffe,

Crawford & Associates, Inc is pleased to submit this Soil Logging Memorandum for the City of Patterson Groundwater Recharge Project located in Stanislaus County, California. We prepared this Memorandum in accordance with our July 5, 2017 agreement. This memorandum is intended to support the design team during the feasibility phase of the groundwater recharge project.

PROJECT DESCRIPTION

We understand the project will help determine the feasibility to supply groundwater recharge within parcels northwest of Patterson, CA. The goal of the project is to recharge groundwater by applying stormwater to infiltration basins. This study will be used to assess the suitability for recharging groundwater within the parcels near the test boring areas.

SCOPE OF SERVICES

To prepare this Memo, CAInc:

- Discussed the proposed boring locations and schedule with Ian Jaffe (RMC) and Paul Rodgers (Gregg Drilling);
- Reviewed the boring locations map provided by RMC;
- Observed and logged by visual method six (6) test borings between July 5 and 13, 2017;

SUBSURFACE EXPLORATION SUMMARY

To characterize the subsurface conditions and obtain soil samples, CAInc observed and logged six (6) test borings. Gregg Drilling scheduled, completed and coordinated the drilling activities between July 5 and 13, 2017. The drilling subcontractor used Marl D12 and Marl M11 truck-mounted rigs to drill the borings with 8-inch outside diameter hollow-stem augers.

Soil samples were recovered by means of 2.0-inch outside diameter (1.4-inch inside diameter, unlined) Standard Penetration (per ASTM D1586) split-spoon samplers driven into the ground with a 140-pound automatic trip hammer falling 30 inches. Hammer energy analysis was not performed specific to this project and Gregg Drilling did not report the hammer efficiency. Therefore, we used an estimated

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hammer efficiency of 75% to determine the N_{60} values and estimate the apparent density of granular soils. The N-values shown on the boring logs are uncorrected "field" blow-count values.

CAInc's Project Engineers/Geologists, Zach Mayo, Hailey Wagenman, Keiko Lewis and Steve Carter logged the borings by the visual method based on the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010 Edition and October 2015 Errata Sheet). Selected portions of soil samples were retained in containers and transported to our office for storage and reference. Laboratory testing has not been requested. Laboratory testing can be completed as an additional service if requested.

We made groundwater observations during drilling operations. At the completion of drilling, borings were backfilled with cement-grout. The boring locations, depths and sampling protocol were determined/directed by RMC. We show the general boring locations on Figure 1. Boring 26 was not completed as planned due to rights of entry denial by the property owner.

GENERALIZED SUBSURFACE CONDITIONS SUMMARY

The attached boring logs show detailed soil descriptions, sampling methods and blow count data.

In general, the soils logged in the test borings consist of layers of silt, lean clay, poorly graded sand with gravel, poorly graded gravel with sand, clayey gravel, poorly graded gravel with silt, sandy silt, silty gravel, poorly graded sand, silty sand, well graded sand with silt and gravel, well graded gravel with silt and sand, clayey sand with gravel to maximum depth explored at about elevation 140.9 feet (ft) below existing ground surface. The relative density of these soils is estimated as medium dense to very dense for the granular layers and stiff to hard for cohesive layers. We measured groundwater in Boring 23 at a depth of 127 ft below the existing ground surface. Groundwater was not encountered in the other borings completed for this study.

Thank you for selecting CAInc to be a part of this project. Please contact us should you have any questions. The retained soil samples are available for laboratory testing if requested.

Sincerely,

Crawford & Associates, Inc.

David P. Castro, PE
Associate Project Manager

Attachments:

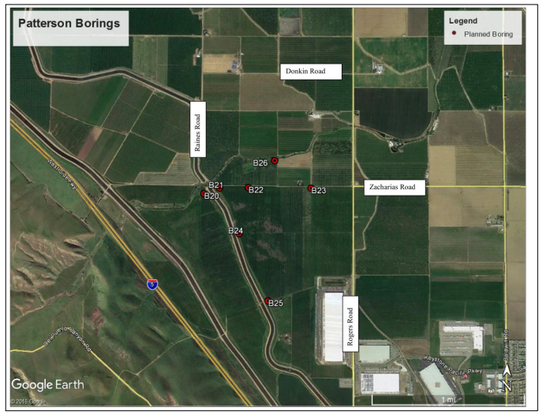
Figure 1
Boring Log Legend
Boring Logs

REGISTERED PROFESSIONAL ENGINEER
DAVID P. CASTRO
C 78093
CIVIL
STATE OF CALIFORNIA

Reviewed by;

Eric Nichols, CEG, PE
Senior Project Manager

REGISTERED PROFESSIONAL ENGINEER
WILLIAM E. NICHOLS
No. 82103
CIVIL
STATE OF CALIFORNIA

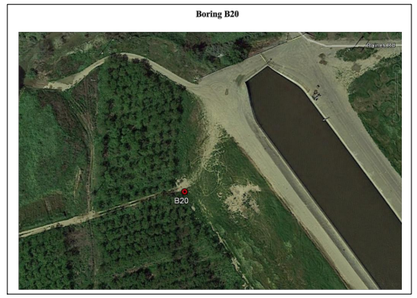


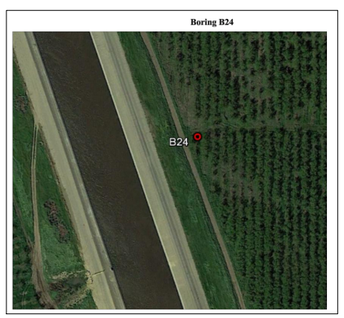
Soil Boring Locations & Owner Information

	Information from Stanislaus County GIS Central *					
Boring	APN (if applicable)	Owner	Site Address	Owner Address	Notes	
B20	021-022-043	Jeffery Arambel	Zacharias Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363	Mr. Arambel has provide an access agreement. The point of contact while the fieldwork is taking place is Joe Hollowell (209-535-4012).	Boring Depth = 140.9 ft, No GW
B21	021-022-042	Jeffery Arambel	Rogers Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363		Boring Depth = 51.5 ft, No GW
B22		Jeffery Arambel	Rogers Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363		Boring Depth = 50.9 ft, No GW
B23	021-022-033	Jeffery Arambel	Zacharias Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363		Boring Depth = 131.5 ft, GW = 127 ft
B24	021-022-042	Jeffery Arambel	Rogers Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363		Boring Depth = 51.5 ft, No GW
B25	021-022-039	Jeffery Arambel	Rogers Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363		Boring Depth = 140.5 ft, No GW
*B26	021-019-019	Jeffery Arambel	Rogers Rd Patterson, CA 95363	433 Roxanne Dr Patterson, CA 95363	Did not complete. Property owner did not allow access.	

Owner info Source: http://gis.stancounty.com/giscentral/public/js/Public_app.html

GW = groundwater depth below existing ground elevation
Boring locations below are approximate.





Locations provided by RMC

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services
Taber Since 1954
1165 Scenic Drive
Suite B
Modesto, CA 95350
(209) 312-7668

North

Project Mgr.	DPC	
Project Eng.		
Designer		
Checked By		
Drawn By	DPC	7/26/17
	By	Date

City of Patterson
Groundwater Recharge Project

Patterson, CA

Figure 1
Exploration Location Map

Project No.	17-391.1
Scale	NTS
Date	7/26/17

UNIFIED SOIL CLASSIFICATION (ASTM D 2487-06)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS <5% FINES	Cu ≥ 4 AND 1 ≤ Cc ≤ 3	GW	WELL-GRADED GRAVEL
			Cu < 4 AND/OR 1 > Cc > 3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS <50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN SANDS <5% FINES	Cu ≥ 6 AND 1 ≤ Cc ≤ 3	SW	WELL-GRADED SAND
			Cu < 6 AND/OR 1 > Cc > 3	SP	POORLY-GRADED SAND
		SANDS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	INORGANIC	PI>7 AND PLOTS ON OR ABOVE "A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS BELOW "A" LINE	ML	SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT >50	INORGANIC	PI PLOTS ON OR ABOVE "A" LINE	CH	FAT CLAY
			PI PLOTS BELOW "A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK COLOR, ORGANIC ODOR		PT	PEAT

NOTE: $Cu = D_{60} / D_{10}$

$Cc = (D_{30})^2 / D_{10} \times D_{60}$

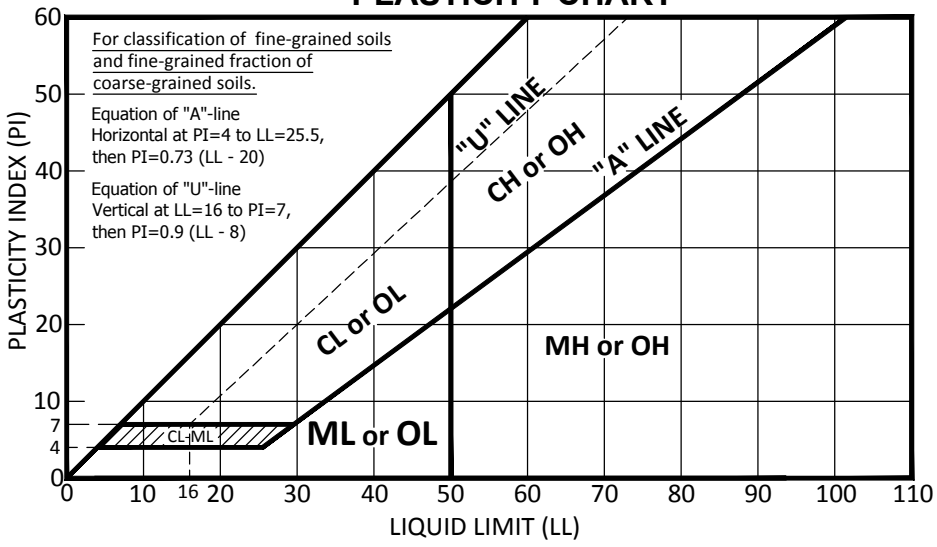
BLOW COUNT

The number of blows of a 140-lb. hammer falling 30-inches required to drive the sampler the last 12-inches of an 18-inch drive. The notation 50/4 indicates 4-inches of penetration achieved in 50 blows.

SAMPLE TYPES

- Auger or backhoe cuttings
- Shelby tube
- Standard Penetration (SPT)
- Modified California (2.0")
- Standard California (2.5")
- Rock core

PLASTICITY CHART



ADDITIONAL TESTS

C	- Consolidation
CP	- Compaction Curve
CR	- Corrosivity Testing
CU	- Consolidated Undrained Triaxial
DS	- Direct Shear
EI	- Expansion Index
P	- Permeability
PA	- Partical Size Analysis
PA+H	- Partical Size and Hydrometer Analysis
PI	- Plasticity Index
PP	- Pocket Penetrometer
R	- R-Value
SE	- Sand Equivalent
SG	- Specific Gravity
SL	- Shrinkage Limit
SW	- Swell Potential
TV	- Pocket Torvane Shear Test
UC	- Unconfined Compression
UU	- Unconsolidated Undrained Triaxial

GROUND WATER LEVELS

- Later water level after drilling
- Water level at time of drilling

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

BORING LOG, TEST PIT LEGEND, AND SOIL DESCRIPTIONS

LOG OF BORING B20

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: KKL, SC
DEPTH OF BORING: 140.9 (ft)

BEGIN DATE: 7/12/2017
COMPLETION DATE: 7/13/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: N/A (ft)
READING TAKEN:
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl D12
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	1							SILT (ML); medium dense; brown; moist; about 10% medium to fine SAND; about 90% low plasticity fines.										
	2																	
	3																	
	4																	
	5	X	1	6 6 10	16	4.5			39									
	6																	
	7																	
	8							Poorly graded SAND with GRAVEL (SP); very dense; light gray; dry; about 40% coarse to fine, angular to subangular GRAVEL, max. 1 in. dia.; about 55% coarse to fine SAND; about 5% nonplastic fines.										
	9																	
	10	X	2	41 50/5	50/5				100									
	11																	
	12																	
	13							Poorly graded GRAVEL with SAND (GP); very dense; about 75% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 20% coarse to fine SAND; about 5% low to medium plasticity fines.										
	14																	
	15	X	3	9 50/5	50/5				45									
	16																	
	17																	
	18							CLAYEY GRAVEL with SAND (GC); very dense; reddish brown; moist; about 70% coarse to fine, subangular to subrounded GRAVEL, max. 0.75 in. dia.; about 15% coarse to fine SAND; about 15% medium plasticity fines.										
	19																	
	20	X	4	40 50/6	50/6				83									
	21																	
	22																	
	23							Poorly graded GRAVEL with SAND (GP); very dense; light gray; dry; about 55% coarse to fine, angular to subangular GRAVEL, max. 1 in. dia.; about 40% coarse to fine SAND; about 5% nonplastic fines.										
	24																	
	25	X	5	50/6	REF				83									
	26																	
	27																	
	28							Poorly graded GRAVEL with SILT (GP-GM); very dense; light brown; moist; about 80% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 10% coarse to fine SAND; about 10% low plasticity fines.										
	29																	
	30	X	6	25 50/4	50/4				70									
	31																	
	32																	
	33							SANDY SILT (ML); dense; brown; moist; about 30% medium to fine SAND; about 70% low plasticity, low toughness fines.										
	34																	

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Geotechnical Engineering, Design and Construction Services

Crawford & Associates, Inc.
1100 Corporate Way, Suite 230
Sacramento, CA 95831
(916) 455-4225

PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B20
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	6 12 14	26	4.5		SANDY SILT (ML) *(continued)*.	33									
	37																	
	38																	
	39							SILTY GRAVEL (GM); very dense; light brown; dry to moist; about 75% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 10% coarse to fine SAND; about 15% low plasticity fines.										
	40		8	6 16 50/4	66/10				69									
	41																	
	42																	
	43																	
	44							Poorly graded GRAVEL with SAND (GP); very dense; light brown; dry; about 50% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 40% coarse to fine SAND; about 10% nonplastic fines.										
	45		9	39 50/3	50/3				100									
	46																	
	47																	
	48																	
	49																	
	50		10	50/4	REF				100									
	51																	
	52																	
	53																	
	54																	
	55		11	50/4	REF				75									
	56																	
	57																	
	58							Poorly graded GRAVEL with SILT and SAND (GP-GM); very dense; light brown; dry; about 60% coarse to fine GRAVEL, max. 1 in. dia.; about 30% coarse to fine SAND; about 10% low to medium plasticity fines.										
	59																	
	60		12	26 36 50/5	86/11				94									
	61																	
	62																	
	63							Poorly graded GRAVEL with SAND (GP); very dense; light gray; dry; about 75% coarse to fine, angular to subangular GRAVEL, max. 1.25 in. dia.; about 25% coarse to fine SAND; nonplastic fines.										
	64																	
	65		13	36 50/2	50/2				100									
	66																	
	67																	
	68							Poorly graded GRAVEL with SILT and SAND (GP-GM); very dense; light brown; dry; about 60% coarse to fine GRAVEL, max. 1.25 in. dia.; about 30% coarse to fine SAND; about 10% low to medium plasticity fines.										
	69																	
	70		14	31 50/3	50/3				100									
	71																	
	72																	
	73							Poorly graded GRAVEL with SAND (GP); very dense; light gray; dry; about 70% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 25% coarse to fine SAND; about 5% nonplastic fines.										
	74																	
	75		15	50/5	REF				100									
	76																	
	77							Poorly graded GRAVEL with SAND (GP) *(continued)*.										

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	78																	
	79							Poorly graded GRAVEL with SAND (GP); very dense; reddish brown; dry to moist; about 60% coarse to fine, subangular to subrounded GRAVEL, max. 1.25 in. dia.; about 30% coarse to fine SAND; about 10% low to medium plasticity fines; Silty CLAY interbedded throughout.										
	80		16	33 50/4	50/4				70									
	81																	
	82																	
	83																	
	84							Poorly graded SAND with SILT (SP-SM); very dense; light brown; dry; about 90% medium to fine SAND; about 10% nonplastic fines.										
	85		17	11 22 30	52				56									
	86																	
	87																	
	88							Poorly graded SAND (SP); very dense; light yellowish brown; dry; about 95% medium to fine SAND; about 5% fines.										
	89																	
	90		18	14 28 39	67				67									
	91																	
	92																	
	93																	
	94																	
	95		19	24 37 43	80				78									
	96																	
	97																	
	98																	
	99							Poorly graded SAND with SILT (SP-SM); very dense; light gray; dry to moist; about 90% fine SAND; about 10% fines; iron staining at 100.0'.										
	100		20	18 29 38	67				56									
	101																	
	102																	
	103																	
	104																	
	105		21	13 32 45	77				39									
	106																	
	107																	
	108							Poorly graded SAND (SP); very dense; light yellowish brown; dry; about 95% medium to fine SAND; about 5% fines.										
	109																	
	110		22	14 28 40	68				61									
	111																	
	112																	
	113																	
	114																	
	115		23	14 40 50/5	90/11				59									
	116																	
	117																	
	118																	
	119							Poorly graded SAND (SP) *(continued)*.										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B20
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	121		24	20 31 50/5	81/11 81/11				53									
	125		25	50/6	REF			SILTY SAND (SM); very dense; olive gray; moist; about 85% medium to fine SAND; about 15% fines.	100									
	130		26	50/2	REF			Well-graded SAND with SILT and GRAVEL (SW-SM); very dense; light brown; moist; about 20% coarse to fine, subrounded GRAVEL, max. 0.75 in. dia.; about 70% fine SAND; about 10% fines.	100									
	135		27	40 50/5	50/5			Well-graded GRAVEL with SILT and SAND (GW-GM); very dense; light brown; dry to moist; about 60% coarse to fine, subrounded GRAVEL, max. 1 in. dia.; about 40% fine SAND; about 10% fines.	82									
	140		28	25 50/5	50/5				64									
	141							Bottom of borehole at 140.9 ft bgs No groundwater encountered										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B20
ENTRY BY: ZM
CHECKED BY:

LOG OF BORING B21

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: ZM
DEPTH OF BORING: 51.5 (ft)

BEGIN DATE: 7/6/2017
COMPLETION DATE: 7/6/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: N/A (ft)
READING TAKEN:
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl M11
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	1							SILTY SAND with GRAVEL (SM); yellowish brown; dry; about 20% coarse to fine GRAVEL; about 50% medium to fine SAND; about 30% fines; (dense).										
	2																	
	3																	
	4																	
	5		1	18 21 15	36			Poorly graded GRAVEL with CLAY and SAND (GP-GC); dense; brown; dry to moist; about 50% coarse to fine, angular to subangular GRAVEL; about 35% coarse to fine SAND; about 15% fines.	67									
	6																	
	7																	
	8																	
	9																	
	10		2	50/5	REF			Very dense.	100									
	11																	
	12																	
	13																	
	14																	
	15		3	50/5	REF				100									
	16							CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 25% coarse, angular to subangular GRAVEL; about 50% coarse to fine SAND; about 25% fines.										
	17																	
	18																	
	19																	
	20		4	35 50/2	50/2			Poorly graded GRAVEL with CLAY and SAND (GP-GC); very dense; grayish brown; dry to moist; about 50% coarse to fine, angular to subangular GRAVEL, max. 4 in. dia.; about 30% coarse to fine SAND; about 20% fines.	100									
	21																	
	22																	
	23																	
	24																	
	25		5	50/3	REF				100									
	26																	
	27																	
	28																	
	29							CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 30% coarse, angular to subangular GRAVEL; about 45% coarse to fine SAND; about 25% fines.										
	30		6	13 44 48	92				67									
	31																	
	32																	
	33																	
	34							SILT (ML); medium dense; brown; moist; about 5% fine										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B21
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	5 9 10	19			SAND; about 95% low plasticity, low toughness fines. SILT (ML) *(continued)*.	100									
	37																	
	38																	
	39							CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 20% coarse, angular to subangular GRAVEL; about 50% coarse to fine SAND; about 30% fines.									
	40		8	18 35 50/5	85/11				100									
	41																	
	42																	
	43																	
	44																	
	45		9	25 31 35	66				100									
	46																	
	47																	
	48																	
	49																	
	50		10	22 30 48	78			Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; brown; moist; about 15% coarse to fine, angular to subangular GRAVEL; about 70% coarse to fine SAND; about 15% fines.	100									
	51							Bottom of borehole at 51.5 ft bgs No groundwater encountered										
	52																	
	53																	
	54																	
	55																	
	56																	
	57																	
	58																	
	59																	
	60																	
	61																	
	62																	
	63																	
	64																	
	65																	
	66																	
	67																	
	68																	
	69																	
	70																	
	71																	
	72																	
	73																	
	74																	
	75																	
	76																	
	77																	

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B21
ENTRY BY: ZM
CHECKED BY:

LOG OF BORING B22

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: ZM
DEPTH OF BORING: 50.92 (ft)

BEGIN DATE: 7/6/2017
COMPLETION DATE: 7/6/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: N/A (ft)
READING TAKEN:
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl M11
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	1							SILTY SAND with GRAVEL (SM); very dense; dark brown; moist; about 20% coarse to fine GRAVEL; about 40% coarse to fine SAND; about 40% fines.										
	2																	
	3																	
	4							CLAYEY GRAVEL with SAND (GC); very dense; , gray, white (10R8/1); moist; about 50% coarse to fine, angular to subangular GRAVEL; about 30% coarse to fine SAND; about 20% fines; max 4 in. dia. cobbles.										
	5	X	1	7 28 28	56				100									
	6																	
	7																	
	8																	
	9																	
	10																	
	11	X	2	7 11 16	27			Medium dense.	22									
	12																	
	13																	
	14																	
	15																	
	16	X	3	26 32 28	60				100									
	17																	
	18																	
	19																	
	20																	
	21	X	4	20 28 35	63				67									
	22																	
	23																	
	24																	
	25																	
	26	X	5	26 29 31	60				0									
	27																	
	28																	
	29																	
	30																	
	31	X	6	21 50/5	50/5				55									
	32																	
	33																	
	34							CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 35% coarse to fine, angular to subangular GRAVEL; about 50% coarse to fine,										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B22
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	14 25 35	60			angular to subangular SAND; about 15% fines. CLAYEY SAND with GRAVEL (SC) *(continued)*.	100									
	37																	
	38																	
	39																	
	40		8	32 44 50/5	94/11				71									
	41																	
	42																	
	43																	
	44							Lean CLAY (CL); stiff; brown; moist; about 5% SAND; about 95% medium plasticity, medium dry strength, medium toughness fines; gradational upper contact.										
	45		9	11 13 4	17				100									
	46																	
	47																	
	48																	
	49							CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 35% coarse to fine, angular to subangular GRAVEL; about 50% coarse to fine, angular to subangular SAND; about 15% fines.										
	50		10	39 50/5	50/5				100									
	51							Bottom of borehole at 50.9 ft bgs No groundwater encountered										
	52																	
	53																	
	54																	
	55																	
	56																	
	57																	
	58																	
	59																	
	60																	
	61																	
	62																	
	63																	
	64																	
	65																	
	66																	
	67																	
	68																	
	69																	
	70																	
	71																	
	72																	
	73																	
	74																	
	75																	
	76																	
	77																	

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B22
ENTRY BY: ZM
CHECKED BY:

LOG OF BORING B23

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: SC, HFW
DEPTH OF BORING: 131.5 (ft)

BEGIN DATE: 7/7/2017
COMPLETION DATE: 7/10/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: 127 (ft)
READING TAKEN: 7/10/2017
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl M11
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	1							CLAYEY SAND with GRAVEL (SC); dense; dry; about 30% coarse to fine, subrounded GRAVEL; about 50% coarse to fine, subangular to subrounded SAND; about 20% fines.										
	2																	
	3																	
	4																	
	5		1	29 13 21	34			Subangular to subrounded GRAVEL.	67									
	6																	
	7																	
	8																	
	9																	
	10		2	16 29 32	61				11									
	11																	
	12																	
	13																	
	14																	
	15		3	25 34 33	67				100									
	16																	
	17							CLAYEY GRAVEL with SAND (GC); very dense; dark gray; dry; about 50% coarse to fine, subrounded GRAVEL; about 30% coarse to fine, subangular to subrounded SAND; about 20% fines.										
	18																	
	19																	
	20		4	15 13 14	27	2.50		Medium dense; about 30% fines.	67									
	21																	
	22							Lean CLAY (CL); very stiff; moist; about 10% fine SAND; about 90% medium plasticity, low toughness fines.										
	23																	
	24							CLAYEY GRAVEL with SAND (GC); very dense; dark gray; moist; about 40% coarse to fine, subrounded GRAVEL; about 30% coarse to fine, subangular to subrounded SAND; about 30% fines.										
	25		5	12 30 35	65				100									
	26																	
	27																	
	28																	
	29																	
	30		6	9 15 30	45	>4.50		Lean CLAY (CL); hard; brown; moist; about 5% coarse to medium SAND; about 95% medium plasticity, medium toughness fines.	83									
	31																	
	32																	
	33																	
	34							CLAYEY SAND with GRAVEL (SC); very dense; dark gray; moist; about 30% coarse to fine, subangular to										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B23
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	24 50/5	50/5			subrounded GRAVEL; about 50% coarse to fine SAND; about 20% fines. CLAYEY SAND with GRAVEL (SC) *(continued)*.	100									
	37																	
	38																	
	39																	
	40		8	33 50/4	50/4				70									
	41																	
	42																	
	43																	
	44																	
	45		9	32 50/5	50/5				36									
	46																	
	47																	
	48							Well-graded SAND with CLAY and GRAVEL (SW-SC); very dense; grayish brown; dry to moist; about 30% coarse to fine, subangular GRAVEL, max. 1 in. dia.; about 60% coarse to fine, subangular to subrounded SAND; about 10% fines.										
	49																	
	50		10	43 50/3	50/3				100									
	51																	
	52																	
	53																	
	54																	
	55		11	15 19 26	45				67									
	56																	
	57																	
	58																	
	59																	
	60		12	6 7 9	16	3.75		SANDY lean CLAY with GRAVEL (CL); very stiff to hard; dark grayish brown; moist; about 15% coarse to fine, subangular to subrounded GRAVEL, max. 0.75 in. dia.; about 25% coarse to fine, subangular to subrounded SAND; about 60% medium plasticity, medium toughness fines.	67									
	61																	
	62																	
	63																	
	64							CLAYEY SAND with GRAVEL (SC); very dense; grayish brown; dry to moist; about 35% coarse to fine, subangular to subrounded GRAVEL, max. 1.5 in. dia.; about 50% coarse to fine, subangular to subrounded SAND; about 15% fines.										
	65		13	25 50/5	50/5				100									
	66																	
	67																	
	68																	
	69																	
	70		14	50/5	REF				100									
	71																	
	72																	
	73							Well-graded GRAVEL with CLAY and SAND (GW-GC); very dense; dark gray; moist; about 60% coarse to fine, subrounded GRAVEL, max. 1.5 in. dia.; about 30% coarse to fine, subangular to subrounded SAND; about 10% fines.										
	74																	
	75		15	50/5	REF				100									
	76																	
	77							Well-graded GRAVEL with CLAY and SAND (GW-GC)										

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	78							*(continued).* CLAYEY SAND with GRAVEL (SC); very dense; brown; moist; about 20% coarse to fine, subrounded GRAVEL, max. 1.3 in. dia.; about 60% coarse to fine, subangular to subrounded SAND; about 20% fines.										
	79																	
	80	X	16	43 50/4	50/4				100									
	81																	
	82																	
	83																	
	84																	
	85	X	17	36 50/4	50/4				100									
	86																	
	87																	
	88																	
	89							Well-graded GRAVEL with CLAY and SAND (GW-GC); very dense; grayish brown; dry; about 60% coarse to fine, angular to subangular GRAVEL, max. 1.5 in. dia.; about 30% coarse to fine, subangular to subrounded SAND; about 10% fines.										
	90	X	18	50/5	REF				100									
	91																	
	92																	
	93																	
	94																	
	95	X	19	50/5	REF				100									
	96							CLAYEY SAND with GRAVEL (SC); very dense; grayish brown; dry; about 25% coarse to fine, subrounded GRAVEL, max. 1.5 in. dia.; about 60% coarse to fine, subrounded SAND; about 15% fines.										
	97																	
	98																	
	99																	
	100	X	20	34 50/5	50/5				91									
	101																	
	102																	
	103																	
	104																	
	105	X	21	10 11 13	24	>4.50		Lean CLAY (CL); very stiff to hard; brown; dry to moist; trace fine SAND; low to medium plasticity, low toughness fines.	83									
	106																	
	107																	
	108																	
	109																	
	110	X	22	10 12 17	29	3.50			50									
	111																	
	112																	
	113																	
	114																	
	115	X	23	7 10 18	28	4.00			100									
	116																	
	117																	
	118																	
	119							Poorly graded SAND (SP); very dense; brown; moist; about 5% fine, subangular GRAVEL; coarse to fine, subangular to subrounded SAND; trace nonplastic										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B23
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LABORATORY: LIQUID LIMIT	LABORATORY: MOISTURE (%)	LABORATORY: D. DENSITY (PCF)	LABORATORY: % PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	121		24	27 50/5	50/5 50/5			fines.	45									
	122																	
	123																	
	124																	
	125		25	30 50/5	50/5				100									
	126																	
	127																	
	128																	
	129																	
	130		26	10 10 13	23				100									
	131																	
	132							Bottom of borehole at 131.5 ft bgs										
	133							Groundwater measured at a depth of 127 feet										
	134																	
	135																	
	136																	
	137																	
	138																	
	139																	
	140																	
	141																	
	142																	
	143																	
	144																	
	145																	
	146																	
	147																	
	148																	
	149																	
	150																	
	151																	
	152																	
	153																	
	154																	
	155																	
	156																	
	157																	
	158																	
	159																	
	160																	
	161																	
	162																	

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B23
ENTRY BY: ZM
CHECKED BY:

LOG OF BORING B24

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: ZM
DEPTH OF BORING: 51.5 (ft)

BEGIN DATE: 7/5/2017
COMPLETION DATE: 7/5/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: N/A (ft)
READING TAKEN:
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl M11
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

FIELD										LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	1							SILTY SAND with GRAVEL (SM); very dense; brown; dry; about 25% fine GRAVEL; about 40% medium to fine SAND; about 35% fines.										
	2																	
	3							Lean CLAY (CL); medium stiff; dark brown; moist; about 10% fine SAND; about 90% medium plasticity, medium toughness fines.										
	4																	
	5		1	17 32 37	69				44									
	6							Poorly graded GRAVEL with CLAY and SAND (GP-GC); very dense; grayish brown; moist; about 50% coarse to fine, angular to subangular GRAVEL; about 30% medium to fine SAND; about 20% fines.										
	7																	
	8																	
	9																	
	10		2	12 11 14	25				67									
	11							Poorly graded SAND with CLAY and GRAVEL (SP-SC); dense; brown; moist; about 25% coarse, angular to subangular GRAVEL; about 50% coarse to fine, angular to subangular SAND; about 25% fines.										
	12																	
	13																	
	14																	
	15		3	10 21 20	41				100									
	16							Poorly graded GRAVEL with CLAY and SAND (GP-GC); very dense; brown; moist; about 55% coarse to fine, subangular to subrounded GRAVEL; about 30% coarse, subangular to subrounded SAND; about 15% fines; max. 4 in dia. cobbles.										
	17																	
	18																	
	19																	
	20		4	50/3	REF				100									
	21																	
	22																	
	23																	
	24																	
	25		5	10 13 14	27			SILT with SAND (ML); medium dense; brown; moist; about 25% fine SAND; about 75% fines.	17									
	26																	
	27																	
	28							Poorly graded SAND with CLAY and GRAVEL (SP-SC); dense to very dense; brown; about 30% coarse to fine, subangular to subrounded GRAVEL; about 50% coarse to fine, subangular to subrounded SAND; about 20% fines.										
	29																	
	30		6	6 6 25	31				100									
	31																	
	32																	
	33																	
	34																	

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B24
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LABORATORY: LIQUID LIMIT	LABORATORY: MOISTURE (%)	LABORATORY: D. DENSITY (PCF)	LABORATORY: % PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	19 29 42	71			Poorly graded SAND with CLAY and GRAVEL (SP-SC) *(continued)*.	67									
	37							SILT (ML); medium dense; yellowish brown; moist; about 10% fine SAND; about 90% fines.										
	38																	
	39																	
	40		8	4 5 7	12				100									
	41																	
	42																	
	43							Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; brown; dry to moist; about 30% coarse to fine, subangular to subrounded GRAVEL; about 50% coarse to fine, subangular to subrounded SAND; about 20% fines.										
	44																	
	45		9	21 50/5	50/5				100									
	46																	
	47																	
	48																	
	49																	
	50		10	30 31 30	61				100									
	51																	
	52							Bottom of borehole at 51.5 ft bgs No groundwater encountered										
	53																	
	54																	
	55																	
	56																	
	57																	
	58																	
	59																	
	60																	
	61																	
	62																	
	63																	
	64																	
	65																	
	66																	
	67																	
	68																	
	69																	
	70																	
	71																	
	72																	
	73																	
	74																	
	75																	
	76																	
	77																	

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B24
ENTRY BY: ZM
CHECKED BY:

LOG OF BORING B25

PROJECT NO: 17-391.1
PROJECT: Patterson GW Recharge
LOCATION: Patterson
COUNTY: Stanislaus
CLIENT:
LOGGED BY: HFW, KKL
DEPTH OF BORING: 140.5 (ft)

BEGIN DATE: 7/7/2017
COMPLETION DATE: 7/11/2017
SURFACE ELEVATION: (ft)
SURFACE CONDITION:
WATER DEPTH: N/A (ft)
READING TAKEN:
HAMMER EFFICIENCY: %

DRILLING CONTRACTOR: Gregg Drilling & Testing, Inc.
DRILLING METHOD: Hollow-Stem Auger
DRILL RIG: Marl D12
HAMMER TYPE: Autotrip, 140 lb, 30 in drop
SAMPLER TYPE & SIZE: SPT (1.4")
BOREHOLE DIAMETER: 8
BACKFILL METHOD: Cement Grout

FIELD									LABORATORY							
ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD / CASING DEPTH	REMARKS
	1–4							Poorly graded SAND with SILT and GRAVEL (SP-SM); very dense; brown; dry; about 20% coarse to fine GRAVEL; about 70% coarse to fine SAND; about 10% fines.									
	5–6	X	1	13 14 28	42				89								
	7–9							Poorly graded SAND with SILT (SP-SM); very dense; brown; dry; about 90% fine SAND; about 5 to 10% fines.									
	10–11	X	2	10 26 42	68				89								
	12–14																
	15–16	X	3	5 15 17	32				72								
	17–19																
	20–21	X	4	10 15 20	35				72								
	22–24																
	25–26	X	5	11 16 21	37				61								
	27–29																
	30–31	X	6	6 16 19	35				61								
	32–34							SILTY SAND (SM); dense; brown; dry; about 60% fine SAND; about 40% fines.									

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B25
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	36		7	9 15 19	34			SILTY SAND (SM) *(continued)*.	67									
	37																	
	38																	
	39							Poorly graded SAND (SP); very dense; brown; dry to moist; fine SAND; trace nonplastic fines.										
	40		8	6 19 22	41				61									
	41																	
	42																	
	43																	
	44							Poorly graded SAND with SILT (SP-SM); dense; brown; dry; about 85% fine SAND; about 15% nonplastic fines.										
	45		9	9 15 23	38				67									
	46																	
	47																	
	48																	
	49							Poorly graded SAND (SP); very dense; brown; dry to moist; about 95% fine SAND; about 5% nonplastic fines.										
	50		10	12 23 32	55				56									
	51																	
	52																	
	53																	
	54																	
	55		11	15 28 38	66				56									
	56																	
	57																	
	58																	
	59																	
	60		12	23 30 19	49	4.5			67									
	61							SANDY lean CLAY (CL); hard; about 10% coarse GRAVEL; about 15 to 20% medium to fine SAND; about 70% medium plasticity fines.										
	62																	
	63																	
	64																	
	65		13	17 31 33	64				67									
	66							Well-graded GRAVEL with SAND (GW); dense; dry; about 60% fine GRAVEL; about 40% coarse to fine SAND; trace fines.										
	67																	
	68																	
	69							SILT (ML); medium dense; brown; dry; about 5% fine GRAVEL; trace SAND; low plasticity fines.										
	70		14	14 16 15	31	4.5			100									
	71																	
	72																	
	73																	
	74																	
	75		15	10 16 21	37				100									
	76																	
	77							SILT (ML) *(continued)*.										

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	78																	
	79																	
	80		16	14 17 27	44			Very dense.	100									
	81																	
	82																	
	83																	
	84																	
	85		17	14 22 23	45	4.5			100									
	86																	
	87																	
	88																	
	89																	
	90		18	6 33 50/4	83/10				83									
	91																	
	92																	
	93							Poorly graded SAND with GRAVEL (SP); very dense; light brown; dry to moist; about 40% coarse to fine, angular to subangular GRAVEL, max. 0.5 in. dia.; about 50% coarse to fine SAND; about 10% nonplastic fines.									
	94																	
	95		19	50/5	REF				100									
	96																	
	97																	
	98																	
	99																	
	100		20	15 50/5	50/5				55									
	101																	
	102																	
	103							Poorly graded GRAVEL with SAND (GP); very dense; light brown; dry to moist; about 70% coarse to fine, angular to subangular GRAVEL, max. 1 in. dia.; about 20 to 35% coarse to fine SAND; about 5 to 10% low to medium plasticity fines.									
	104																	
	105		21	50/6	REF				100									
	106																	
	107																	
	108																	
	109																	
	110		22	50/5	REF				100									
	111																	
	112																	
	113																	
	114																	
	115		23	50/6	REF				100									
	116																	
	117																	
	118																	
	119							Poorly graded GRAVEL with SAND (GP) *(continued)*.										

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PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B25
ENTRY BY: ZM
CHECKED BY:

ELEVATION (ft)	DEPTH (ft)	SAMPLE	SAMPLE NO	BLOWS PER 6 IN.	BLOWS PER FOOT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	RECOVERY(%)	RQD (%)	LABORATORY: PLASTIC LIMIT	LIQUID LIMIT	MOISTURE (%)	D. DENSITY (PCF)	% PASSING 200 SIEVE	DRILL METHOD	CASING DEPTH	REMARKS
	120		24	50/4	REF				100									
	121																	
	122																	
	123																	
	124																	
	125							Poorly graded SAND with GRAVEL (SP); very dense; light brown; dry to moist; about 30% coarse to fine, subangular to subrounded GRAVEL; about 60% coarse to fine SAND; about 10% nonplastic fines.									
	126																	
	127																	
	128																	
	129																	
	130		25	30 50/3	50/3				67									
	131																	
	132																	
	133							Poorly graded GRAVEL with SAND (GP); very dense; light brown; dry; about 75% coarse to fine, angular to subangular GRAVEL, max. 1 in. dia.; about 20% coarse to fine SAND; about 5 to 10% nonplastic fines.									
	134																	
	135		26	50/3	REF				100									
	136																	
	137																	
	138																	
	139																	
	140		27	50/6	REF			About 55% coarse to fine, subangular to subrounded GRAVEL; about 40% coarse to fine SAND; about 5% nonplastic fines.	100									
	141							Bottom of borehole at 140.5 ft bgs										
	142							No groundwater encountered										
	143																	
	144																	
	145																	
	146																	
	147																	
	148																	
	149																	
	150																	
	151																	
	152																	
	153																	
	154																	
	155																	
	156																	
	157																	
	158																	
	159																	
	160																	
	161																	
	162																	

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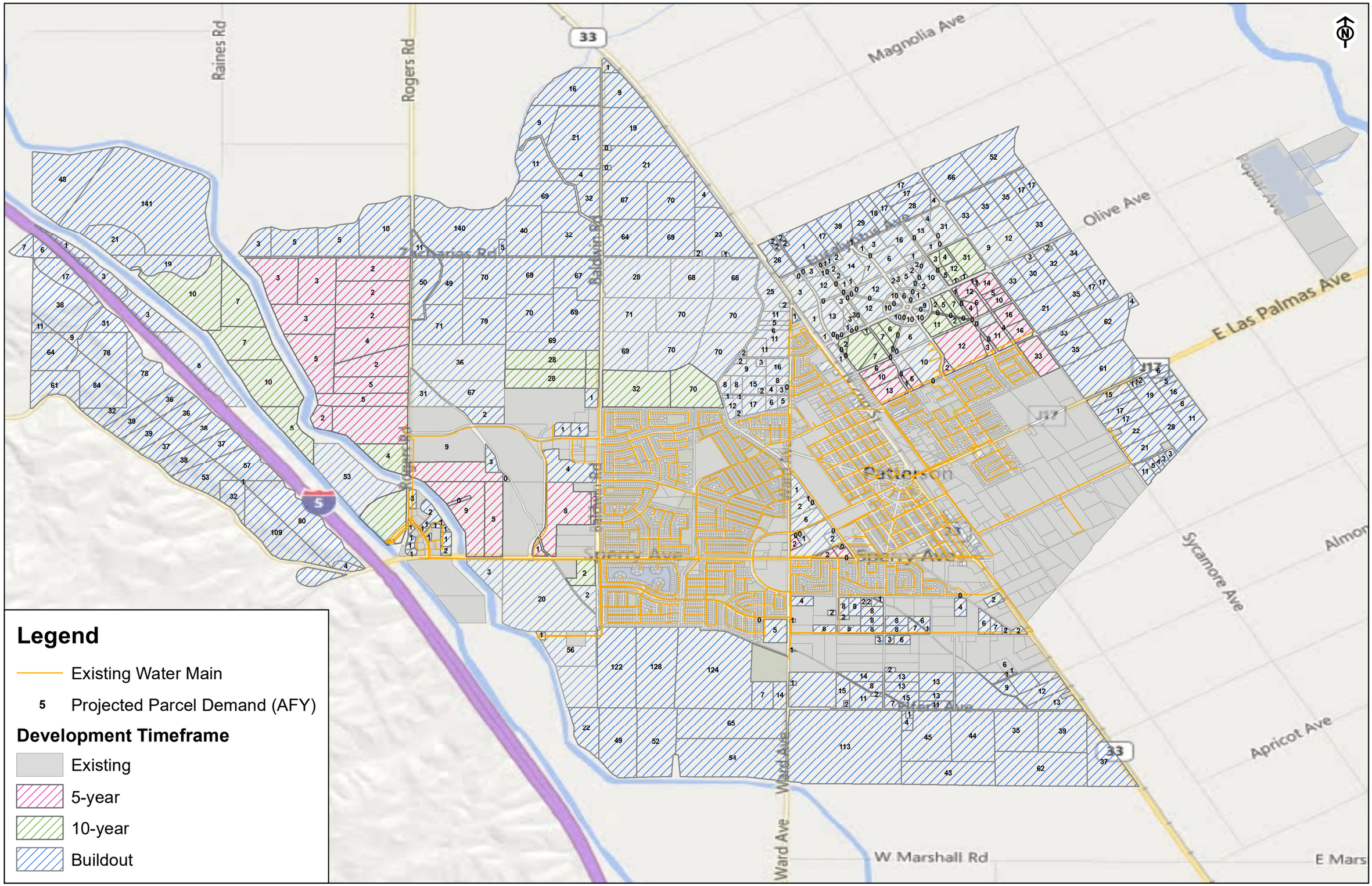
PROJECT NUMBER: 17-391.1
PROJECT: Patterson GW Recharge
EXPLORATION: B25
ENTRY BY: ZM
CHECKED BY:

Appendix E - Parcel Development Phasing Map


Raines Rd
Rogers Rd
33
Magnolia Ave
Olive Ave
E Las Palmas Ave
Zaslavsky Rd
Baldwin Rd
Stevenson Ave
Sycamore Ave
Apricot Ave
Ward Ave
W Marshall Rd
E Mars
5
J17
Legend
Existing Water Main
5 Projected Parcel Demand (AFY)
Development Timeframe
Existing
5-year
10-year
Buildout

Appendix F - Detailed CIP Project Cost Estimates

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	ST-1
LOCATION:	
BRIEF PROJECT DESCRIPTION:	New 1.0 MG Storage Tank (Zone 3)
MODEL REFERENCE:	
PROPOSED PROJECT PHASING:	5-year
REASON FOR PROJECT:	New storage to meet peak day demands and fire flow for Zone 3 (through buildout)
SPECIAL CONSIDERATIONS:	
ASSUMPTIONS:	It has been assumed that there is adequate space at the existing City site to accommodate a new tank. This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.
ALTERNATIVES:	Build a tank at another site or reconfigure the distribution system to merge Zone 3 with Zone 2 (eliminating the need for this storage)

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Tank Construction Cost					
Site Grading		1	LS	$45,000	$45,000
Site Improvements (fencing, security, lighting)		1	LS	$15,000	$15,000
Tank Controls		1	LS	$96,000	$96,000
Fittings, piping and connections		1	LS	$56,000	$56,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Structures, Storage Tanks, and Pump Stations					
Storage Tank - 0.5 MG (Steel)		0	EA	$515,000	$0
Storage Tank - 0.75 MG (Steel)		0	EA	$664,000	$0
Storage Tank - 1.0 MG (Steel)		1	EA	$815,000	$815,000
Storage Tank - 2.0 MG (Steel)		0	EA	$1,289,000	$0
Storage Tank - 4.0 MG (Steel)		0	EA	$2,620,000	$0
Storage Tank test			LS	$5,000	$5,000
Subtotal					$1,037,000
Mobilization and Demobilization				**3%**	$31,110
Construction Cost Subtotal					**$1,068,110**
Contengencies for Unknown Conditions				**30%**	$320,433
Construction Cost Total					**$1,388,543**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs [1]				**27%**	$374,907
Capital Improvement Cost Total					**$1,763,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: ST-2

LOCATION: At new wellfield (northwest portion of the City)

BRIEF PROJECT DESCRIPTION: New 1.25 MG Storage Tank (Zone 2)

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 10-year

REASON FOR PROJECT: New storage to meet peak day demands and fire flow for Zone 2

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: It has been assumed that there is adequate space at the existing City site to accommodate a new tank. This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Build a tank with more capacity at this site, build a tank at another site

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Tank Construction Cost					
Site Grading		1	LS	$45,000	$45,000
Site Improvements (fencing, security, lighting)		1	LS	$15,000	$15,000
Tank Controls		1	LS	$96,000	$96,000
Fittings, piping and connections		1	LS	$56,000	$56,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Structures, Storage Tanks, and Pump Stations					
Storage Tank - 0.5 MG (Steel)		0	EA	$515,000	$0
Storage Tank - 0.75 MG (Steel)		0	EA	$664,000	$0
Storage Tank - 1.0 MG (Steel)		0	EA	$815,000	$0
Storage Tank - 1.25 MG (Steel)		1	EA	$1,085,000	$1,085,000
Storage Tank - 1.5 MG (Steel)		0	EA	$1,157,000	$0
Storage Tank - 2.0 MG (Steel)		0	EA	$1,289,000	$0
Storage Tank - 4.0 MG (Steel)		0	EA	$2,620,000	$0
Storage Tank test			LS	$5,000	$5,000
Subtotal					$1,307,000
Mobilization and Demobilization				**3%**	$39,210
Construction Cost Subtotal					**$1,346,210**
Contengencies for Unknown Conditions				**30%**	$403,863
Construction Cost Total					**$1,750,073**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$472,520
Capital Improvement Cost Total					**$2,223,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services Durin Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: ST-BO1

LOCATION: Located at new well site (site of potential centralized treatment)

BRIEF PROJECT DESCRIPTION: New 3.0 MG Storage Tank (Zone 1)

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: New storage to meet peak day demands and fire flow for Zone 1

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Build a tank with more capacity earlier in CIP, build a tank at another site

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Tank Construction Cost					
Site Grading		1	LS	$45,000	$45,000
Site Improvements (fencing, security, lighting)		1	LS	$21,000	$21,000
Tank Controls		1	LS	$96,000	$96,000
Fittings, piping and connections		1	LS	$84,000	$84,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Structures, Storage Tanks, and Pump Stations					
Storage Tank - 0.5 MG (Steel)		0	EA	$515,000	$0
Storage Tank - 0.75 MG (Steel)		0	EA	$664,000	$0
Storage Tank - 1.0 MG (Steel)		0	EA	$815,000	$0
Storage Tank - 2.0 MG (Steel)		0	EA	$1,289,000	$0
Storage Tank - 3.0 MG (Steel)		1	EA	$2,150,000	$2,150,000
Storage Tank - 4.0 MG (Steel)		0	EA	$2,620,000	$0
Storage Tank test			LS	$5,000	$5,000
Subtotal					$2,406,000
Mobilization and Demobilization				**3%**	$72,180
Construction Cost Subtotal					**$2,478,180**
Contengencies for Unknown Conditions				**30%**	$743,454
Construction Cost Total					**$3,221,634**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs [1]				**27%**	$869,841.18

Capital Improvement Cost Total **$4,091,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... ST-BO2

LOCATION:..... Near T2

BRIEF PROJECT DESCRIPTION:..... New 2.0 MG Storage Tank (Zone 2)

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: .....

REASON FOR PROJECT:..... New storage to meet peak day demands and fire flow for Zone 2

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:..... This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES:..... Build a tank with more capacity earlier in CIP, build a tank at another site

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Tank Construction Cost					
Site Grading		1	LS	$45,000	$45,000
Site Improvements (fencing, security, lighting)		1	LS	$18,000	$18,000
Tank Controls		1	LS	$96,000	$96,000
Fittings, piping and connections		1	LS	$56,000	$56,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Structures, Storage Tanks, and Pump Stations					
Storage Tank - 0.5 MG (Steel)		0	EA	$515,000	$0
Storage Tank - 0.75 MG (Steel)		0	EA	$664,000	$0
Storage Tank - 1.0 MG (Steel)		0	EA	$815,000	$0
Storage Tank - 2.0 MG (Steel)		1	EA	$1,289,000	$1,289,000
Storage Tank - 4.0 MG (Steel)		0	EA	$2,620,000	$0
Storage Tank test			LS	$5,000	$5,000
Subtotal					$1,514,000
Mobilization and Demobilization				**3%**	$45,420
Construction Cost Subtotal					**$1,559,420**
Contengencies for Unknown Conditions				**30%**	$467,826
Construction Cost Total					**$2,027,246**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs [1]				**27%**	$547,356

Capital Improvement Cost Total **$2,575,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: ST-BO3

LOCATION: Western hills (to serve new pressure zone).

BRIEF PROJECT DESCRIPTION: New 2.25 MG Storage Tank (Zone 4)

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: New storage to meet peak day demands and fire flow for Zone 4

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Build a tank at another site

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Tank Construction Cost					
Site Grading		1	LS	$45,000	$45,000
Site Improvements (fencing, security, lighting)		1	LS	$19,500	$19,500
Tank Controls		1	LS	$96,000	$96,000
Fittings, piping and connections		1	LS	$84,000	$84,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Structures, Storage Tanks, and Pump Stations					
Storage Tank - 0.5 MG (Steel)		0	EA	$515,000	$0
Storage Tank - 0.75 MG (Steel)		0	EA	$664,000	$0
Storage Tank - 1.0 MG (Steel)		0	EA	$815,000	$0
Storage Tank - 2.0 MG (Steel)		0	EA	$1,289,000	$0
Storage Tank - 2.25 MG (Steel)		1	EA	$1,482,000	$1,482,000
Storage Tank - 4.0 MG (Steel)		0	EA	$2,620,000	$0
Storage Tank test			LS	$5,000	$5,000
Subtotal					$1,736,500
Mobilization and Demobilization				**3%**	$52,095
Construction Cost Subtotal					**$1,788,595**
Contengencies for Unknown Conditions				**30%**	$536,579
Construction Cost Total					**$2,325,174**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs [1]				**27%**	$627,797
Capital Improvement Cost Total					**$2,953,000**

ENR = 11,555 (S.F. August 2016)

[1] Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... WT-1

LOCATION:.....

BRIEF PROJECT DESCRIPTION:..... Re-coat Storage Tank (Zone 1)

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: 5-year

REASON FOR PROJECT:..... Storage tank needs to be re-coated ensure water quality and tank useful life.

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Structures, Storage Tanks, and Pump Stations					
Re-coat Storage Tank	1 MG	1	EA	260,000 $/EA	$260,000
Subtotal					$260,000
Mobilization and Demobilization				**3%**	
Construction Cost Subtotal					**$260,000**
Contengencies for Unknown Conditions				**30%**	$78,000
Construction Cost Total					**$338,000**
Capital Improvement Cost Total					**$338,000**

ENR = 11,555 (S.F. August 2016)

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION	
PROJECT ID:	WT-2
LOCATION:	
BRIEF PROJECT DESCRIPTION:	Re-coat Storage Tank (Zone 2)
MODEL REFERENCE:	
PROPOSED PROJECT PHASING:	10-year
REASON FOR PROJECT:	Storage tank needs to be re-coated ensure water quality and tank useful life.
SPECIAL CONSIDERATIONS:	
ASSUMPTIONS:	
ALTERNATIVES:	

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Structures, Storage Tanks, and Pump Stations					
Re-coat Storage Tank	1.5 MG	1	EA	286,000 $/EA	$286,000
Subtotal					$286,000
Mobilization and Demobilization				**3%**	
Construction Cost Subtotal					**$286,000**
Contengencies for Unknown Conditions				**30%**	$85,800
Construction Cost Total					**$371,800**
Capital Improvement Cost Total					**$372,000**

ENR = 11,555 (S.F. August 2016)

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION	
PROJECT ID:	WT-3
LOCATION:	
BRIEF PROJECT DESCRIPTION:	Re-coat Storage Tank (Zone 3)
MODEL REFERENCE:	
PROPOSED PROJECT PHASING:	5-year
REASON FOR PROJECT:	Storage tank needs to be re-coated ensure water quality and tank useful life.
SPECIAL CONSIDERATIONS:	
ASSUMPTIONS:	
ALTERNATIVES:	

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Structures, Storage Tanks, and Pump Stations					
Re-coat Storage Tank	0.9 MG	1	EA	260,000 $/EA	$260,000
Subtotal					$260,000
Mobilization and Demobilization				**3%**	
Construction Cost Subtotal					**$260,000**
Contengencies for Unknown Conditions				**30%**	$78,000
Construction Cost Total					**$338,000**
Capital Improvement Cost Total					**$338,000**

ENR = 11,555 (S.F. August 2016)

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WL-1

LOCATION: New wellfield (NW Patterson near Zacharias Road)

BRIEF PROJECT DESCRIPTION: Construct a new well in the northwest portion of the City serving Zone 2.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 10-year

REASON FOR PROJECT: Meet future demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: n/a ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Well and Pump					
Well Construction and Testing	shallow	0	LS	$ 800,000	$0
Well Construction and Testing	deep	1	LS	$ 1,140,000	$1,140,000
Submersible Pump		1	EA	$ 55,000	$55,000
Pad Structure for Pump or Vault/Manhole		1	LS	$ 15,000	$15,000
Water Level Monitor and Temp Logger		1	EA	$ 10,000	$10,000
Piping and Appurtenances					
Misc. Gauges, Valves, Etc. Allowance		10%	LS	$1,220,000	$122,000
Treatment Facilities					
Chlorine Equipment (valve, controls, etc)		1	LS	$ 87,000	$87,000
Electrical					
Electrical and Control		1	LS	$ 50,000	$50,000
Subtotal					$1,479,000
Mobilization and Demobilization				**3%**	$44,370
Construction Cost Subtotal					**$1,523,370**
Contengencies for Unknown Conditions				**30%**	$457,011
Construction Cost Total					**$1,980,381**
Permtting				**15%**	$297,057
Land Acquisition - Permanent Easement Cost		100' wide	100'	25 $/sf	$250,000
Engineering, Administration, and Legal Costs[1]				**27%**	$534,703
Capital Improvement Cost Total					**$3,062,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	PP-1
LOCATION:	Located near Del Puerto Creek and I-5
BRIEF PROJECT DESCRIPTION:	New percolation ponds to capture and recharge stormwater from Del Puerto Cree
MODEL REFERENCE:	
PROPOSED PROJECT PHASING:	5-year
REASON FOR PROJECT:	New water supply (basin recharge feeds groundwater wells).
SPECIAL CONSIDERATIONS:	
ASSUMPTIONS:	This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.
ALTERNATIVES:	

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Site Work					
Site Work		14	Acre	$160,000	$2,240,000
Misc. Concret		14	Acre	$30,000	$420,000
Misc. Metals		14	Acre	$6,000	$84,000
Other					
Mechanical Allowance		14	Acre	$118,000	$1,652,000
Subtotal					$4,396,000
Mobilization and Demobilization				**3%**	$131,880
Construction Cost Subtotal					**$4,527,880**
Contengencies for Unknown Conditions				**30%**	$1,358,364
Construction Cost Total					**$5,886,244**
Engineering, Administration, and Legal Costs [1]				**27%**	$1,589,285.88
Capital Improvement Cost Total					**$7,476,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... WL-2

LOCATION:..... Near existing wells, Highway 33.

BRIEF PROJECT DESCRIPTION:..... Construct a new well serving Zone 1.

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: ..... Buildout

REASON FOR PROJECT:..... Meet future demands.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:..... n/a ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Well and Pump					
Well Construction and Testing	shallow	0	LS	$ 800,000	$0
Well Construction and Testing	deep	1	LS	$ 1,140,000	$1,140,000
Submersible Pump		1	EA	$ 55,000	$55,000
Pad Structure for Pump or Vault/Manhole		1	LS	$ 15,000	$15,000
Water Level Monitor and Temp Logger		1	EA	$ 10,000	$10,000
Piping and Appurtenances					
Misc. Gauges, Valves, Etc. Allowance		10%	LS	$1,220,000	$122,000
Treatment Facilities					
Chlorine Equipment (valve, controls, etc)		1	LS	$ 87,000	$87,000
Electrical					
Electrical and Control		1	LS	$ 50,000	$50,000
Subtotal					$1,479,000
Mobilization and Demobilization				**3%**	$44,370
Construction Cost Subtotal					**$1,523,370**
Contengencies for Unknown Conditions				**30%**	$457,011
Construction Cost Total					**$1,980,381**
Permtting				**15%**	$297,057
Land Acquisition - Permanent Easement Cost		100' wide	100'	25 $/sf	$250,000
Engineering, Administration, and Legal Costs[1]				**27%**	$534,703
Capital Improvement Cost Total					**$3,062,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... WL-3

LOCATION:..... New wellfield (NW Patterson near Zacharias Road)

BRIEF PROJECT DESCRIPTION:..... Construct 4 new wells in the northwest portion of the City serving Zone 2.

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: ..... Buildout

REASON FOR PROJECT:..... Meet future demands.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:..... n/a ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Well and Pump					
Well Construction and Testing	shallow	0	LS	$ 800,000	$0
Well Construction and Testing	deep	4	LS	$ 1,140,000	$4,560,000
Submersible Pump		4	EA	$ 55,000	$220,000
Pad Structure for Pump or Vault/Manhole		4	LS	$ 15,000	$60,000
Water Level Monitor and Temp Logger		4	EA	$ 10,000	$40,000
Piping and Appurtenances					
Misc. Gauges, Valves, Etc. Allowance		10%	LS	$4,880,000	$488,000
Treatment Facilities					
Chlorine Equipment (valve, controls, etc)		4	LS	$ 87,000	$348,000
Electrical					
Electrical and Control		4	LS	$ 50,000	$200,000
Subtotal					$5,916,000
Mobilization and Demobilization				**3%**	$177,480
Construction Cost Subtotal					**$6,093,480**
Contengencies for Unknown Conditions				**30%**	$1,828,044
Construction Cost Total					**$7,921,524**
Permtting				**15%**	$1,188,229
Land Acquisition - Permanent Easement Cost		100' wide	100'	25 $/sf	$250,000
Engineering, Administration, and Legal Costs[1]				**27%**	$2,138,811

Capital Improvement Cost Total **$11,499,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: PS-0

LOCATION: New Zone 2 (Arambel) Tank

BRIEF PROJECT DESCRIPTION: Add a pump station to pressure zone 2 at the new Zone 2 (Arambel) tank to meet demand/pressure requirements.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 5-year

REASON FOR PROJECT: Pump needed to draw from new tank to meet fire flow requirements in pressure zone 2.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: At buildout this pump station will need to deliver around 4,000 gpm at 150 ft during PHD conditions. Near term the station will need to devlier aroung 1,900 gpm at 80 ft during PHD conditions but demands on pump will be reduced when new well field/tank/pump is constructed.

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Pump					
Pump	180 HP (VSP)	3	EA	$ 117,000	$351,000
Fitting Allowance		1	LS	$ 100,000	$100,000
Valve Allowance		3	EA	$ 62,000	$186,000
Pad Structure		1	EA	$ 15,000	$15,000
Electrical					
Electrical and Control		1	LS	$ 50,000	$50,000
Subtotal					$702,000
Mobilization and Demobilization				**3%**	$21,060
Construction Cost Subtotal					**$723,060**
Contengencies for Unknown Conditions				**30%**	$216,918
Construction Cost Total					**$939,978**
Engineering, Administration, and Legal Costs[1]				**27%**	$253,794

Capital Improvement Cost Total **$1,444,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... PS-1

LOCATION:..... New Tank at new wellfield (near Zacharias Road)

BRIEF PROJECT DESCRIPTION:..... Add a pump to pressure zone 2 at the new wellfield tank to meet flow requiremer

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: 10-year

REASON FOR PROJECT:..... Pump needed to meet fire flow requirements in pressure zone 2.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:.... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:..... At buildout this pump station will need to deliver around 4,000 gpm at 160 ft during PHD conditions. Upon installation, the station will need to devlier around 1,100 gpm at 70 ft during PHD conditions.

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Pump					
Pump	180 HP (VSP)	3	EA	$ 117,000	$351,000
Fitting Allowance		1	LS	$ 100,000	$100,000
Valve Allowance		3	EA	$ 62,000	$186,000
Pad Structure		1	EA	$ 15,000	$15,000
Electrical					
Electrical and Control		1	LS	$ 50,000	$50,000
Subtotal					$702,000
Mobilization and Demobilization				**3%**	$21,060
Construction Cost Subtotal					**$723,060**
Contengencies for Unknown Conditions				**30%**	$216,918
Construction Cost Total					**$939,978**
Engineering, Administration, and Legal Costs[1]				**27%**	$253,794

Capital Improvement Cost Total **$1,444,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: PS-BO-1

LOCATION: Tank 3 (Gateway) pump station area

BRIEF PROJECT DESCRIPTION: Add a pump to serve the tank in the new pressure zone (Zone 4) in the western hills.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: Buildout

REASON FOR PROJECT: Pump needed to serve Zone 4.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Pump					
Pump	240 HP	2	EA	$ 145,000	$290,000
Fitting Allowance		1	LS	$ 100,000	$100,000
Valve Allowance		2	EA	$ 62,000	$124,000
Pad Structure		1	EA	$ 15,000	$15,000
Electrical					
Electrical and Control		1	LS	$ 50,000	$50,000
Subtotal					$579,000
Mobilization and Demobilization				**3%**	$17,370
Construction Cost Subtotal					**$596,370**
Contengencies for Unknown Conditions				**30%**	$178,911
Construction Cost Total					**$775,281**
Engineering, Administration, and Legal Costs[1]				**27%**	$209,326
Capital Improvement Cost Total					**$1,235,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-ST-0

LOCATION: From Zone 2 to new tank at Arambel development (near Zacharias Road)

BRIEF PROJECT DESCRIPTION: Install 2421 lf of new 16-inch pipe

MODEL REFERENCE: CIPBO_2016_5494, CIPBO_2016_5496, CIPBO_2016_5498

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to serve the new Zone 2 (Arambel) tank.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	2,421'	LF	203 $/ft	$491,127
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		6	EA	2,575 $/EA	$15,450
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	5	EA	15,500 $/EA	$77,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		2,421'	LF	$ 5	$11,000
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	2,421'	8.00 $/sf	$96,840
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$691,917
Mobilization and Demobilization				**3%**	$20,758
Construction Cost Subtotal					**$712,675**
Contengencies for Unknown Conditions				**30%**	$213,802
Construction Cost Total					**$926,477**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$250,149
Capital Improvement Cost Total					**$1,177,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-1A

LOCATION: Area bounded by Sperry Ave to the north, Poppy Ave to the south, Del Puerto Ave to the west and by the irrigation canal to the east east of Marisa Dr)

BRIEF PROJECT DESCRIPTION: Replace approximately 6,880 lf of existing pipe with 3,250 lf of 6-inch pipe, 2,320 lf of 8-inch pipe and 1,310 lf of 10-inch pipe and the connecting service lines. Additionally, replaced 20 service lines located along Clover Ave.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline and service line replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	3,253'	LF	79 $/ft	$257,434
Pipe (PVC)	8	2,317'	LF	91 $/ft	$211,426
Pipe (PVC)	10	1,310'	LF	124 $/ft	$161,910
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		6,880'	LF	6 $/ft	$41,452
Connection to Existing System		24	EA	2,575 $/EA	$61,800
Service Line Reconnections		192	EA	1,000 $/EA	$192,000
Fire Hydrant Connection		14	EA	1,000 $/EA	$14,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	7	EA	1,125 $/EA	$7,875
Gate Valve	8	5	EA	1,500 $/EA	$7,500
Gate Valve	10	3	EA	2,050 $/EA	$6,150
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		6,880'	LF	$ 5	$31,270
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$31,539
Surface Restoration					
Pavement Restoration		5' wide	6,880'	8.00 $/sf	$275,200
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$1,299,556
Mobilization and Demobilization				**3%**	$38,987
Construction Cost Subtotal					**$1,338,542**
Contengencies for Unknown Conditions				**30%**	$401,563
Construction Cost Total					**$1,740,105**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$469,828
Capital Improvement Cost Total					**$2,210,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-1B

LOCATION: Area bounded by Sperry Ave to the north, Poppy Ave to the south,Del Puerto Ave to the west and by the irrigation canal to the east east of Marisa Dr)

BRIEF PROJECT DESCRIPTION: Replace approximately 10,300 lf of existing pipe with 790 lf of 6-inch pipe, 6,100 lf of 8-inch pipe and 3,380 lf of 10-inch pipe.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	789'	LF	79 $/ft	$62,439
Pipe (PVC)	8	6,088'	LF	91 $/ft	$555,530
Pipe (PVC)	10	3,379'	LF	124 $/ft	$417,628
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		10,256'	LF	6 $/ft	$61,792
Connection to Existing System		20	EA	2,575 $/EA	$51,500
Service Line Reconnections		212	EA	1,000 $/EA	$212,000
Fire Hydrant Connection		25	EA	1,000 $/EA	$25,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	2	EA	1,125 $/EA	$2,250
Gate Valve	8	13	EA	1,500 $/EA	$19,500
Gate Valve	10	7	EA	2,050 $/EA	$14,350
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		10,256'	LF	$ 5	$46,620
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$51,780
Surface Restoration					
Pavement Restoration		5' wide	10,256'	8.00 $/sf	$410,240
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$1,930,630
Mobilization and Demobilization				**3%**	$57,919
Construction Cost Subtotal					**$1,988,548**
Contengencies for Unknown Conditions				**30%**	$596,565
Construction Cost Total					**$2,585,113**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$697,981
Capital Improvement Cost Total					**$3,283,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-2

LOCATION: Washburn Street, Unidad Court, Weber Avenue, Tenbrink Lane, Walnut Avenue, N 1st St, N Hartley St

BRIEF PROJECT DESCRIPTION: Replace 4240 lf of existing pipe with 4-inch. 6-inch, 8-inch, 10-inch, 12-inch and 16-inch pipe

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	222'	LF	67 $/ft	$14,880
Pipe (PVC)	6	1,495'	LF	79 $/ft	$118,311
Pipe (PVC)	8	382'	LF	91 $/ft	$34,858
Pipe (PVC)	10	1,007'	LF	124 $/ft	$124,460
Pipe (PVC)	12	1,042'	LF	158 $/ft	$164,408
Pipe (PVC)	16	92'	LF	203 $/ft	$18,663
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		4,240'	LF	6 $/ft	$25,546
Connection to Existing System		14	EA	2,575 $/EA	$36,050
Service Line Reconnections		82	EA	1,000 $/EA	$82,000
Fire Hydrant Connection		7	EA	1,000 $/EA	$7,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	1	EA	1,000 $/EA	$1,000
Gate Valve	6	3	EA	1,125 $/EA	$3,375
Gate Valve	8	1	EA	1,500 $/EA	$1,500
Gate Valve	10	3	EA	2,050 $/EA	$6,150
Gate Valve	12	3	EA	5,150 $/EA	$15,450
Gate Valve	16	1	EA	15,500 $/EA	$15,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		4,240'	LF	$ 5	$19,270
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$23,779
Surface Restoration					
Pavement Restoration		5' wide	4,240'	8.00 $/sf	$169,600
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$881,799
Mobilization and Demobilization				**3%**	$26,454
Construction Cost Subtotal					**$908,253**
Contengencies for Unknown Conditions				**30%**	$272,476
Construction Cost Total					**$1,180,729**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$318,797
Capital Improvement Cost Total					**$1,500,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-2

LOCATION: Washburn Street, Unidad Court, Weber Avenue, Tenbrink Lane, Walnut Avenue, N 1st St, N Hartley St

BRIEF PROJECT DESCRIPTION: Replace 4240 lf of existing pipe with 4-inch. 6-inch, 8-inch, 10-inch, 12-inch and 16-inch pipe

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	1,042'	LF	158 $/ft	$164,408
Pipe (PVC)	16	92'	LF	203 $/ft	$18,663
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		1,134'	LF	6 $/ft	$6,832
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Reconnections		10	EA	1,000 $/EA	$10,000
Fire Hydrant Connection		7	EA	1,000 $/EA	$7,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	3	EA	5,150 $/EA	$15,450
Gate Valve	16	1	EA	15,500 $/EA	$15,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1,134'	LF	$ 5	$5,150
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$9,154
Surface Restoration					
Pavement Restoration		5' wide	1,134'	8.00 $/sf	$45,360
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$307,817
Mobilization and Demobilization				**3%**	$9,235
Construction Cost Subtotal					**$317,051**
Contengencies for Unknown Conditions				**30%**	$95,115
Construction Cost Total					**$412,167**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$111,285
Capital Improvement Cost Total					**$523,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-3

LOCATION: Mary Jane Avenue, Vicki Lynn Lane, Roxanne Drive, Susan Street

BRIEF PROJECT DESCRIPTION: Replace 2661 lf of existing pipe with 8-inch pipe and replace service lines along additional 2000 lf of pipe (around 40 additional service lines)

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes and service lines at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	2,661'	LF	91 $/ft	$242,816
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		2,661'	LF	6 $/ft	$16,033
Connection to Existing System		12	EA	2,575 $/EA	$30,900
Service Line Reconnections		103	EA	1,000 $/EA	$103,000
Fire Hydrant Connection		11	EA	1,000 $/EA	$11,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	6	EA	1,500 $/EA	$9,000
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		2,661'	LF	$ 5	$12,100
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$12,141
Surface Restoration					
Pavement Restoration		5' wide	2,661'	8.00 $/sf	$106,440
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$543,430
Mobilization and Demobilization				**3%**	$16,303
Construction Cost Subtotal					**$559,732**
Contengencies for Unknown Conditions				**30%**	$167,920
Construction Cost Total					**$727,652**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$196,466
Capital Improvement Cost Total					**$924,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-4

LOCATION: Barros Street, Mertz Court, Delphia Drive, McNaughton Court, Lilac Avenue, Hammon Court, Lola Lane/Court, Wanzia Lane/Court

BRIEF PROJECT DESCRIPTION: Replace about 5,000 lf of existing pipe with 2,500 lf of 6-inch pipe and 2,500 lf of 8-inch pipe.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	2,889'	LF	79 $/ft	$228,628
Pipe (PVC)	8	2,472'	LF	91 $/ft	$225,570
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		5,361'	LF	6 $/ft	$32,300
Connection to Existing System		16	EA	2,575 $/EA	$41,200
Service Line Reconnections		121	EA	1,000 $/EA	$121,000
Fire Hydrant Connection		9	EA	1,000 $/EA	$9,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	6	EA	1,125 $/EA	$6,750
Gate Valve	8	5	EA	1,500 $/EA	$7,500
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		5,361'	LF	$ 5	$24,370
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$22,710
Surface Restoration					
Pavement Restoration		5' wide	5,361'	8.00 $/sf	$214,440
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$933,468
Mobilization and Demobilization				**3%**	$28,004
Construction Cost Subtotal					**$961,472**
Contengencies for Unknown Conditions				**30%**	$288,442
Construction Cost Total					**$1,249,914**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$337,477
Capital Improvement Cost Total					**$1,587,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-5

LOCATION: Sunset Court, , K St, C St, Near S 1st St

BRIEF PROJECT DESCRIPTION: Replace 201 lf of existing 6-inch pipe, upsize 906 lf of pipe to 10-inch and install 121 lf of new 6-inch pipe.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	322'	LF	79 $/ft	$25,482
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	906'	LF	124 $/ft	$111,977
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		1,107'	LF	6 $/ft	$6,670
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Reconnections		8	EA	1,000 $/EA	$8,000
Fire Hydrant Connection		1	EA	1,000 $/EA	$1,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	1	EA	1,125 $/EA	$1,125
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	2	EA	2,050 $/EA	$4,100
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1,228'	LF	$ 5	$5,580
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$6,873
Surface Restoration					
Pavement Restoration		5' wide	1,107'	8.00 $/sf	$44,280
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$235,687
Mobilization and Demobilization				**3%**	$7,071
Construction Cost Subtotal					**$242,758**
Contengencies for Unknown Conditions				**30%**	$72,827
Construction Cost Total					**$315,585**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$85,208
Capital Improvement Cost Total					**$401,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-6A

LOCATION: Bounded by El Circulo Ave

BRIEF PROJECT DESCRIPTION: Replace around 10,180 lf of existing pipe with 4, 6, and 8-inch pipe

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	4,425'	LF	67 $/ft	$296,586
Pipe (PVC)	6	3,061'	LF	79 $/ft	$242,240
Pipe (PVC)	8	2,698'	LF	91 $/ft	$246,193
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		9,976'	LF	6 $/ft	$60,105
Connection to Existing System		44	EA	2,575 $/EA	$113,300
Service Line Reconnections		124	EA	1,000 $/EA	$124,000
Fire Hydrant Connection		20	EA	1,000 $/EA	$20,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	9	EA	1,000 $/EA	$9,000
Gate Valve	6	7	EA	1,125 $/EA	$7,875
Gate Valve	8	6	EA	1,500 $/EA	$9,000
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		10,184'	LF	$ 5	$46,290
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$39,251
Surface Restoration					
Pavement Restoration		5' wide	9,976'	8.00 $/sf	$399,040
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$1,612,879
Mobilization and Demobilization				**3%**	$48,386
Construction Cost Subtotal					**$1,661,266**
Contengencies for Unknown Conditions				**30%**	$498,380
Construction Cost Total					**$2,159,645**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$583,104
Capital Improvement Cost Total					**$2,743,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-6B

LOCATION: Area bounded by W Las Palmas Ave, S 9th St, Sperry Ave, Del Puerto Ave and S El Circulo Ave

BRIEF PROJECT DESCRIPTION: Replace around 17,750 lf of existing pipe with 4, 6, 8 and 10-inch pipe and install around 1,000 lf or new 6 and 8-inch pipe.

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline replacement of pipes at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	6,352'	LF	67 $/ft	$425,743
Pipe (PVC)	6	7,543'	LF	79 $/ft	$596,934
Pipe (PVC)	8	4,646'	LF	91 $/ft	$423,948
Pipe (PVC)	10	1,204'	LF	124 $/ft	$148,809
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		17,756'	LF	6 $/ft	$106,980
Connection to Existing System		74	EA	2,575 $/EA	$190,550
Service Line Reconnections		197	EA	1,000 $/EA	$197,000
Fire Hydrant Connection		14	EA	1,000 $/EA	$14,000
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	13	EA	1,000 $/EA	$13,000
Gate Valve	6	16	EA	1,125 $/EA	$18,000
Gate Valve	8	10	EA	1,500 $/EA	$15,000
Gate Valve	10	3	EA	2,050 $/EA	$6,150
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		19,745'	LF	$ 5	$89,750
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$79,772
Surface Restoration					
Pavement Restoration		5' wide	17,756'	8.00 $/sf	$710,240
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$3,035,875
Mobilization and Demobilization				**3%**	$91,076
Construction Cost Subtotal					**$3,126,951**
Contengencies for Unknown Conditions				**30%**	$938,085
Construction Cost Total					**$4,065,036**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$1,097,560
Capital Improvement Cost Total					**$5,163,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-7

LOCATION: S. Hartley Avenue, Sears Drive, Paramatta Drive, Chesterfield Drive, Chesterfield Court, Westfield Place/Court, Messer Place, Yancey Court

BRIEF PROJECT DESCRIPTION: Replace around 150 service lines along 5600 lf of existing pipe

MODEL REFERENCE:

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Service line replacement of services at the end of their useful life.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		0'	LF	6 $/ft	$0
Connection to Existing System		0	EA	2,575 $/EA	$0
Service Line Reconnections		152	EA	1,000 $/EA	$152,000
Fire Hydrant Connection		0	EA	1,000 $/EA	$0
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		0'	LF	$ 5	$0
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$0
Surface Restoration					
Pavement Restoration		5' wide	0'	8.00 $/sf	$0
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$152,000
Mobilization and Demobilization				**3%**	$4,560
Construction Cost Subtotal					**$156,560**
Contengencies for Unknown Conditions				**30%**	$46,968
Construction Cost Total					**$203,528**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$54,953
Capital Improvement Cost Total					**$258,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:	WM-8
LOCATION:	La Lynn Drive, Enrique Way, El Camino Drive, Franco Way, Pasa Felix Drive, La Maria Way, Shirlinda Way
BRIEF PROJECT DESCRIPTION:	Replace 3049 lf of existing pipe with 6-inch pipe (diameter to be confirmed).
MODEL REFERENCE:	
PROPOSED PROJECT PHASING:	2017
REASON FOR PROJECT:	Pipeline replacement of pipes at the end of their useful life.
PIPE DESIGN:	
MAXIMUM FLOW AT BUILD OUT:	gpm
MAXIMUM HEADLOSS AT BUILD OUT:	ft/1000ft
SPECIAL CONSIDERATIONS:	
ASSUMPTIONS:	The City indicated that they did not know the existing pipe diameter. It has been assumed that the pipe will be replaced with 6-inch pipe, but that will need to be confirmed. This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.
ALTERNATIVES:	Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	2	0'	LF	55 $/ft	$0
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	3,049'	LF	79 $/ft	$241,290
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		3,049'	LF	6 $/ft	$18,370
Connection to Existing System		14	EA	2,575 $/EA	$36,050
Service Line Reconnections		0	EA	1,000 $/EA	$0
Fire Hydrant Connection		0	EA	1,000 $/EA	$0
Gate Valve	2	0	EA	875 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	7	EA	1,125 $/EA	$7,875
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		3,049'	LF	$ 5	$13,860
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		5%	$12,065
Surface Restoration					
Pavement Restoration		5' wide	3,049'	8.00 $/sf	$121,960
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$451,470
Mobilization and Demobilization				**3%**	$13,544
Construction Cost Subtotal					**$465,014**
Contengencies for Unknown Conditions				**30%**	$139,504
Construction Cost Total					**$604,518**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$163,220
Capital Improvement Cost Total					**$768,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-9

LOCATION: Near PS and Rogers Rd

BRIEF PROJECT DESCRIPTION: Upsize 1725 lf of existing pipe with 12-inch pipe and install 68 lf of new 12-inch pipe

MODEL REFERENCE: Pipes P4682, P4690, CIPEX_2016_5038

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline upsizes and additions to meet pressure and velocity requirements.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	1,793'	LF	158 $/ft	$282,901
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Pipe (PVC)	24	0'	LF	316 $/ft	$0
Abandon main in place		1,725'	LF	6 $/ft	$10,393
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Reconnections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	4	EA	5,150 $/EA	$20,600
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Gate Valve	24	0	EA	36,000 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1,793'	LF	$ 5	$8,150
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	1,725'	8.00 $/sf	$69,000
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$401,344
Mobilization and Demobilization				**3%**	$12,040
Construction Cost Subtotal					**$413,385**
Contengencies for Unknown Conditions				**30%**	$124,015
Construction Cost Total					**$537,400**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$145,098
Capital Improvement Cost Total					**$682,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-10

LOCATION: Ward Ave, N 2nd St, Highway 33, Near Bear Hallow Dr, and Near Deer Hallow

BRIEF PROJECT DESCRIPTION: Upsize 1824 lf of existing pipe with 10-inch main and 735 lf with 12-inch pipe and install 218 lf of new 12-inch main.

MODEL REFERENCE: Pipes 2, 5, CIPEX_2016_5086, 1, 2015P4770, 9, 2015P4774, P2248

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline upsizes and additions to meet pressure and velocity requirements.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	1,824'	LF	124 $/ft	$225,437
Pipe (PVC)	12	953'	LF	158 $/ft	$150,365
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		2,559'	LF	6 $/ft	$15,418
Connection to Existing System		14	EA	2,575 $/EA	$36,050
Service Line Reconnections		17	EA	1,000 $/EA	$17,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	4	EA	2,050 $/EA	$8,200
Gate Valve	12	2	EA	5,150 $/EA	$10,300
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Misc. Pipe Appurtenances (valves, hydrants)				0%	$0
Jacking Pits			0 pits	$40,000	$0
Receiving Pits			0 pits	$15,000	$0
Traffic and Construction Productivity Factors					
Traffic Control		2,777'	LF	$ 5	$12,620
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	2,559'	8.00 $/sf	$102,360
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$577,751
Mobilization and Demobilization				**3%**	$17,333
Construction Cost Subtotal					**$595,083**
Contengencies for Unknown Conditions				**30%**	$178,525
Construction Cost Total					**$773,608**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$208,874
Capital Improvement Cost Total					**$982,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-11

LOCATION: Baldwin Rd and Keystone Pacific Parkway

BRIEF PROJECT DESCRIPTION: Upsize 1731 lf of existing pipe with 12-inch pipe and upsize 1393 lf with 16-inch pipe.

MODEL REFERENCE: Pipes P53, 2015P4702, P871

PROPOSED PROJECT PHASING: 2017

REASON FOR PROJECT: Pipeline upsizes and additions to meet pressure and velocity requirements.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This cost estimate was performed at the master planning level and should be further reviewed before proceeding with the projects.

ALTERNATIVES: Install parellel pipe.

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	1,731'	LF	158 $/ft	$273,119
Pipe (PVC)	16	1,393'	LF	203 $/ft	$282,586
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place		3,124'	LF	6 $/ft	$18,822
Connection to Existing System		6	EA	2,575 $/EA	$15,450
Service Line Reconnections		7	EA	1,000 $/EA	$7,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	4	EA	5,150 $/EA	$20,600
Gate Valve	16	3	EA	15,500 $/EA	$46,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		3,124'	LF	$ 5	$14,200
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	3,124'	8.00 $/sf	$124,960
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$803,237
Mobilization and Demobilization				**3%**	$24,097
Construction Cost Subtotal					**$827,334**
Contengencies for Unknown Conditions				**30%**	$248,200
Construction Cost Total					**$1,075,534**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$290,394
Capital Improvement Cost Total					**$1,366,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-12

LOCATION: N 1st and Between Walnut Ave and Olive Ave, Between Walnut Ave and Olive Ave, Sycamore Ave, Olive Ave

BRIEF PROJECT DESCRIPTION: Install 813 lf of new 10-inch pipe and 7735 lf of new 12-inch pipe

MODEL REFERENCE: Pipes CIP5Y_2016_5378, CIP5Y_2016_5380, CIPFUT_2016_5104 and CIP10Y_2016_5160, CIP5Y_2016_5128, Pipes CIP5Y_2016_5132

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	813'	LF	124 $/ft	$100,483
Pipe (PVC)	12	7,735'	LF	158 $/ft	$1,220,436
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		10	EA	2,575 $/EA	$25,750
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	2	EA	2,050 $/EA	$4,100
Gate Valve	12	16	EA	5,150 $/EA	$82,400
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Jacking Shaft		1	EA	$300,000	$300,000
Receiving Shaft		1	EA	$150,000	$150,000
Trenchless Tunelling		1	EA	$400,000	$400,000
Traffic and Construction Productivity Factors					
Traffic Control		8,548'	LF	$ 5	$38,855
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	3,279'	8.00 $/sf	$131,160
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,453,183
Mobilization and Demobilization				**3%**	$73,595
Construction Cost Subtotal					**$2,526,779**
Contengencies for Unknown Conditions				**30%**	$758,034
Construction Cost Total					**$3,284,812**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$886,899
Capital Improvement Cost Total					**$4,172,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-13

LOCATION: Between Keystone Pacific Pkwy and CR-237, Between Keystone Pacific Pkwy and CR-237

BRIEF PROJECT DESCRIPTION: Install 5247 lf of new 12-inch pipe.

MODEL REFERENCE: CIP5Y_2016_1694, CIP5Y_2016_5384

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	5,247'	LF	158 $/ft	$827,877
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	11	EA	5,150 $/EA	$56,650
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		5,247'	LF	$ 5	$23,850
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	200'	8.00 $/sf	$8,000
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$926,677
Mobilization and Demobilization				**3%**	$27,800
Construction Cost Subtotal					**$954,477**
Contengencies for Unknown Conditions				**30%**	$286,343
Construction Cost Total					**$1,240,820**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$335,021
Capital Improvement Cost Total					**$1,576,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-14

LOCATION: Acacia Ave, Between Orange Ave and Fig Ave

BRIEF PROJECT DESCRIPTION: Install 2713 lf of new 12-inch pipe

MODEL REFERENCE: Pipes CIP5Y_2016_5136, CIP5Y_2016_5172

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	2,713'	LF	158 $/ft	$428,060
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	6	EA	5,150 $/EA	$30,900
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Jacking Shaft		1	EA	$300,000	$300,000
Receiving Shaft		1	EA	$150,000	$150,000
Trenchless Tunelling		1	EA	$400,000	$400,000
Traffic and Construction Productivity Factors					
Traffic Control		2,713'	LF	$ 5	$12,332
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	1,393'	8.00 $/sf	$55,720
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$1,387,312
Mobilization and Demobilization				**3%**	$41,619
Construction Cost Subtotal					**$1,428,931**
Contengencies for Unknown Conditions				**30%**	$428,679
Construction Cost Total					**$1,857,610**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$501,555
Capital Improvement Cost Total					**$2,359,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-15

LOCATION: Zacharias Rd, Rogers Rd, Between Raines Rd and Rogers Rd

BRIEF PROJECT DESCRIPTION: Install 5540 lf of new 8-inch and 10500 lf of new 12-inch pipe

MODEL REFERENCE: Pipes CIP5Y_2016_5112, CIP5Y_2016_5110, CIP5Y_2016_5124, CIP5Y_2016_5126, CIP5Y_2016_5108, CIPBO_2016_5164, CIPBO_2016_5536, CIP5Y_2016_5114

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	5,538'	LF	91 $/ft	$505,343
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	10,501'	LF	158 $/ft	$1,656,858
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		16	EA	2,575 $/EA	$41,200
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	12	EA	1,500 $/EA	$18,000
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	22	EA	5,150 $/EA	$113,300
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		16,039'	LF	$ 5	$72,905
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	10,501'	8.00 $/sf	$420,040
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,827,645
Mobilization and Demobilization				**3%**	$84,829
Construction Cost Subtotal					**$2,912,474**
Contengencies for Unknown Conditions				**30%**	$873,742
Construction Cost Total					**$3,786,217**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$1,022,279
Capital Improvement Cost Total					**$4,808,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-16

LOCATION: Near Delta-Mendota Canal, Between Raines Rd and Rogers Rd, Near Delta-Mendota Canal, Near Arambel Tank

BRIEF PROJECT DESCRIPTION: Install 4440 lf of new 8-inch pipe, 7040 lf of new 12-inch pipe and 2350 lf of new 16-inch pipe.

MODEL REFERENCE: Pipes CIP5Y_2016_5120 and CIP5Y_2016_5116, CIP5Y_2016_5118, CIP5Y_2016_5122, CIPBO_2016_5470

PROPOSED PROJECT PHASING: 5-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	4,437'	LF	91 $/ft	$404,876
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	7,044'	LF	158 $/ft	$1,111,409
Pipe (PVC)	16	2,346'	LF	203 $/ft	$475,913
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Connections		7	EA	1,000 $/EA	$7,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	9	EA	1,500 $/EA	$13,500
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	15	EA	5,150 $/EA	$77,250
Gate Valve	16	5	EA	15,500 $/EA	$77,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		13,827'	LF	$ 5	$62,850
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	0'	8.00 $/sf	$0
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,257,898
Mobilization and Demobilization				**3%**	$67,737
Construction Cost Subtotal					**$2,325,635**
Contengencies for Unknown Conditions				**30%**	$697,690
Construction Cost Total					**$3,023,325**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$816,298
Capital Improvement Cost Total					**$3,840,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-17

LOCATION: North of Swan Dr and Austin Park

BRIEF PROJECT DESCRIPTION: Install 1459 lf of new 10-inch pipe

MODEL REFERENCE: Pipes CIP10Y_2016_5166

PROPOSED PROJECT PHASING: 10-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	1,459'	LF	124 $/ft	$180,325
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		2	EA	2,575 $/EA	$5,150
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	3	EA	2,050 $/EA	$6,150
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1,459'	LF	$ 5	$6,632
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	0'	8.00 $/sf	$0
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$198,257
Mobilization and Demobilization				**3%**	$5,948
Construction Cost Subtotal					**$204,205**
Contengencies for Unknown Conditions				**30%**	$61,261
Construction Cost Total					**$265,466**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$71,676
Capital Improvement Cost Total					**$337,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-18

LOCATION: Baldwin Rd, North of Keystone Pacific Pkwy and North of Swan Dr and Austin Park

BRIEF PROJECT DESCRIPTION: Install 8080 lf of new 12-inch pipe

MODEL REFERENCE: Pipes CIP10Y_2016_5190, CIP10Y_2016_5154, CIP10Y_2016_5152, CIP10Y_2016_5148, CIP10Y_2016_5150, CIPBO_2016_5232, CIPBO_2016_5234

PROPOSED PROJECT PHASING: 10-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	8,079'	LF	158 $/ft	$1,274,713
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		12	EA	2,575 $/EA	$30,900
Service Line Connections		10	EA	1,000 $/EA	$10,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	17	EA	5,150 $/EA	$87,550
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		8,079'	LF	$ 5	$36,723
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	1,212'	8.00 $/sf	$48,480
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$1,498,365
Mobilization and Demobilization				**3%**	$44,951
Construction Cost Subtotal					**$1,543,316**
Contengencies for Unknown Conditions				**30%**	$462,995
Construction Cost Total					**$2,006,311**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$541,704
Capital Improvement Cost Total					**$2,548,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-19

LOCATION: Sycamore Ave, Olive Ave, Between N 1st St and Sycamore Ave

BRIEF PROJECT DESCRIPTION: Install 6870 lf of new 12-inch pipe.

MODEL REFERENCE: Pipes CIP10Y_2016_5162, CIP10Y_2016_5158, CIPBO_2016_5376, CIPBO_2016_5374

PROPOSED PROJECT PHASING: 10-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	6,867'	LF	158 $/ft	$1,083,482
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Connections		24	EA	1,000 $/EA	$24,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	14	EA	5,150 $/EA	$72,100
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Jacking Shaft		1	EA	$300,000	$300,000
Receiving Shaft		1	EA	$150,000	$150,000
Trenchless Tunelling		1	EA	$400,000	$400,000
Traffic and Construction Productivity Factors					
Traffic Control		6,867'	LF	$ 5	$31,214
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	5,574'	8.00 $/sf	$222,960
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,328,356
Mobilization and Demobilization				**3%**	$69,851
Construction Cost Subtotal					**$2,398,206**
Contengencies for Unknown Conditions				**30%**	$719,462
Construction Cost Total					**$3,117,668**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$841,770
Capital Improvement Cost Total					**$3,959,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... WM-20

LOCATION:..... Near California Aqueduct

BRIEF PROJECT DESCRIPTION:..... Install 9139 lf of new 16-inch pipe

MODEL REFERENCE:..... Pipes CIP10Y_2016_5138

PROPOSED PROJECT PHASING: ..... 10-year CIP

REASON FOR PROJECT:..... New pipeline to facility City growth and new demands.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:..... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	9,139'	LF	203 $/ft	$1,853,949
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Connections		4	EA	1,000 $/EA	$4,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	19	EA	15,500 $/EA	$294,500
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		9,139'	LF	$ 5	$41,541
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	0'	8.00 $/sf	$0
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoratior		0' wide	0'	2.00 $/sf	$0
Revegetatior		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,208,290
Mobilization and Demobilization				**3%**	$66,249
Construction Cost Subtotal					**$2,274,539**
Contengencies for Unknown Conditions				**30%**	$682,362
Construction Cost Total					**$2,956,900**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$798,363
Capital Improvement Cost Total					**$3,755,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: WM-21

LOCATION: Zacharias Rd, Near California Aqueduct and Delta-Mendota Canal

BRIEF PROJECT DESCRIPTION: Install 9450 lf of new 12-inch pipe and 670 lf of new 16-inch pipe.

MODEL REFERENCE: Pipes CIP10Y_2016_5142, CIP10Y_2016_5144, CIP10Y_2016_5146, CIP10Y_2016_5140

PROPOSED PROJECT PHASING: 10-year CIP

REASON FOR PROJECT: New pipeline to facility City growth and new demands.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	9,454'	LF	158 $/ft	$1,491,661
Pipe (PVC)	16	672'	LF	203 $/ft	$136,323
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Connections		3	EA	1,000 $/EA	$3,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	19	EA	5,150 $/EA	$97,850
Gate Valve	16	2	EA	15,500 $/EA	$31,000
Gate Valve	20	0	EA	25,500 $/EA	$0
Jacking Shaft		1	EA	$300,000	$300,000
Receiving Shaft		1	EA	$150,000	$150,000
Trenchless Tunelling		1	EA	$400,000	$400,000
Traffic and Construction Productivity Factors					
Traffic Control		10,126'	LF	$ 5	$46,027
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	0'	8.00 $/sf	$0
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$2,679,461
Mobilization and Demobilization				**3%**	$80,384
Construction Cost Subtotal					**$2,759,845**
Contengencies for Unknown Conditions				**30%**	$827,954
Construction Cost Total					**$3,587,799**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$968,706
Capital Improvement Cost Total					**$4,557,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... WM-BO

LOCATION:..... Various developments and expansion projects around Patterson.

BRIEF PROJECT DESCRIPTION:..... Install 234,384 lf of new pipe

MODEL REFERENCE:..... Includes 127 pipe segments based on initial pipe alignments.

PROPOSED PROJECT PHASING: ..... Buildout CIP

REASON FOR PROJECT:..... New pipeline to facility City growth and new demands.

PIPE DESIGN:.....

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	235,232'	LF	124 $/ft	$29,073,523
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Abandon main in place			LF	6 $/ft	$0
Connection to Existing System		35	EA	2,575 $/EA	$90,125
Service Line Connections		100	EA	1,000 $/EA	$100,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	471	EA	2,050 $/EA	$965,550
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		235,232'	LF	$ 5	$1,069,236
Increased Traffic Control			0'	10 $/ft	$0
Congested Traffic or Utility Corridor Factor		5% of baseline pipe cost		0%	$0
Remove and Replace Factor		5% of baseline pipe cost		0%	$0
Surface Restoration					
Pavement Restoration		5' wide	235,232'	8.00 $/sf	$9,409,280
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Landscape Restoration		0' wide	0'	2.00 $/sf	$0
Revegetation		0' wide	0'	0.25 $/sf	$0
Subtotal					$40,707,714
Mobilization and Demobilization				**3%**	$1,221,231
Construction Cost Subtotal					**$41,928,946**
Contengencies for Unknown Conditions				**30%**	$12,578,684
Construction Cost Total					**$54,507,629**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$14,717,060
Capital Improvement Cost Total					**$69,225,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: TT-1

LOCATION: Water Quality Control Facility

BRIEF PROJECT DESCRIPTION: Construct a new tertiary filtration system at the WQCF to produce Title 22 compliant recycled water.

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: Serve non-potable demans within the City.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS: This treatment train will divert a portion of the total WQCF flow (roughly 1.5mgd) for additional treatment and distribution through the City's non-potable system.

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Sitework					
Sitework		1	EA	1,500 $/EA	$1,500
Building					
Concrete		1	EA	334,000 $/EA	$334,000
Metals (stairs, rails, etc.)		1	EA	62,500 $/EA	$62,500
Finish/Coating Allowance		1	EA	32,000 $/EA	$32,000
Treatment Facilities					
Filter and Pump		1	EA	400,000 $/EA	$400,000
Effluent Turbidity Analyzer		1	EA	5,000 $/EA	$5,000
Equipment Installation		1	EA	60,000 $/EA	$60,000
Miscellaneous Filter/Material Allowance		1	EA	20,000 $/EA	$20,000
Piping and Appurtenances					
Pipe/Valve/Fitting Allowance		1	EA	85,000 $/EA	$85,000
Subtotal					$1,000,000
Mobilization and Demobilization				**3%**	$30,000
Construction Cost Subtotal					**$1,030,000**
Contengencies for Unknown Conditions				**30%**	$309,000
Construction Cost Total					**$1,339,000**
Engineering, Administration, and Legal Costs[1]				**27%**	$361,530
Capital Improvement Cost Total					**$1,951,000**

ENR = 11,555 (S.F. August 2016)

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... NP-1

LOCATION:.....Ward Ave, W Las Palmas Ave

BRIEF PROJECT DESCRIPTION:..... Install 300 lf of new 6-inch 2500 lf of new 10-inch non-potable pipe

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: .....

REASON FOR PROJECT:..... New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	292'	LF	79 $/ft	$23,108
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	2,463'	LF	124 $/ft	$304,415
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		4	EA	2,575 $/EA	$10,300
Service Line Connections		3	EA	1,000 $/EA	$3,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	1	EA	1,125 $/EA	$1,125
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	5	EA	2,050 $/EA	$10,250
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	2,755'	8.00 $/sf	$110,200
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$475,398
Mobilization and Demobilization				**3%**	$14,262
Construction Cost Subtotal					**$489,660**
Contengencies for Unknown Conditions				**30%**	$146,898
Construction Cost Total					**$636,558**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$171,871
Capital Improvement Cost Total					**$808,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... NP-2

LOCATION:..... M St, Walnut Ave, N Hartley St

BRIEF PROJECT DESCRIPTION:..... Install 1060 lf of new 4-inch and 5900 lf of new 12-inch non-potable pipe

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: .....

REASON FOR PROJECT:..... New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	1,064'	LF	67 $/ft	$71,315
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	6,287'	LF	158 $/ft	$991,969
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Connections		7	EA	1,000 $/EA	$7,000
Gate Valve	4	3	EA	1,000 $/EA	$3,000
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	13	EA	5,150 $/EA	$66,950
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	7,351'	8.00 $/sf	$294,040
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$1,471,874
Mobilization and Demobilization				**3%**	$44,156
Construction Cost Subtotal					**$1,516,030**
Contengencies for Unknown Conditions				**30%**	$454,809
Construction Cost Total					**$1,970,839**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$532,126

Capital Improvement Cost Total **$2,503,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: NP-3A

LOCATION: Sperry Ave, Baldwin Rd, Jersey Ln, Park Center Dr

BRIEF PROJECT DESCRIPTION: Install 7550 lf of new 4-inch and 6770 lf of new 8-inch non-potable pipe

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	7,546'	LF	67 $/ft	$505,771
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	6,765'	LF	91 $/ft	$617,306
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		20	EA	2,575 $/EA	$51,500
Service Line Connections		17	EA	1,000 $/EA	$17,000
Gate Valve	4	16	EA	1,000 $/EA	$16,000
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	14	EA	1,500 $/EA	$21,000
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	14,311'	8.00 $/sf	$572,440
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$1,819,017
Mobilization and Demobilization				**3%**	$54,571
Construction Cost Subtotal					**$1,873,587**
Contengencies for Unknown Conditions				**30%**	$562,076
Construction Cost Total					**$2,435,664**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$657,629
Capital Improvement Cost Total					**$3,093,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... NP-3B

LOCATION:.....American Eagle Ave and Calvinson Pkwy

BRIEF PROJECT DESCRIPTION:..... Install 2600 lf of new 4-inch non-potable pipe

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: .....

REASON FOR PROJECT:..... New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	2,600'	LF	67 $/ft	$174,265
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	0'	LF	158 $/ft	$0
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		2	EA	2,575 $/EA	$5,150
Service Line Connections		3	EA	1,000 $/EA	$3,000
Gate Valve	4	6	EA	1,000 $/EA	$6,000
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	0	EA	5,150 $/EA	$0
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	2,600'	8.00 $/sf	$104,000
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$305,415
Mobilization and Demobilization				**3%**	$9,162
Construction Cost Subtotal					**$314,577**
Contengencies for Unknown Conditions				**30%**	$94,373
Construction Cost Total					**$408,951**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$110,417
Capital Improvement Cost Total					**$519,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: NP-4

LOCATION: Near Sycamore Ave, Olive Ave, Walnut Ave N 2nd St

BRIEF PROJECT DESCRIPTION: Install 7590 lf of new 8-inch and 2630 lf of new 10-inch and 1200 lf of new 12-inch non-potable pipe.

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	7,922'	LF	91 $/ft	$722,883
Pipe (PVC)	10	2,625'	LF	124 $/ft	$324,437
Pipe (PVC)	12	1,200'	LF	158 $/ft	$189,337
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		8	EA	2,575 $/EA	$20,600
Service Line Connections		25	EA	1,000 $/EA	$25,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	16	EA	1,500 $/EA	$24,000
Gate Valve	10	6	EA	2,050 $/EA	$12,300
Gate Valve	12	3	EA	5,150 $/EA	$15,450
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Jacking Shaft		1	EA	$300,000	$300,000
Receiving Shaft		1	EA	$150,000	$150,000
Trenchless Tunelling		1	EA	$400,000	$400,000
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	11,747'	8.00 $/sf	$469,880
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$2,688,887
Mobilization and Demobilization				**3%**	$80,667
Construction Cost Subtotal					**$2,769,553**
Contengencies for Unknown Conditions				**30%**	$830,866
Construction Cost Total					**$3,600,419**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$972,113
Capital Improvement Cost Total					**$4,573,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID:..... NP-5

LOCATION:..... Rogers Rd, Zacharias Rd

BRIEF PROJECT DESCRIPTION:..... Install 11292 lf of new 12-inch non-potable pipe

MODEL REFERENCE:.....

PROPOSED PROJECT PHASING: .....

REASON FOR PROJECT:..... New non-potable pipeline to expand non-potable deliveries around the City.

PIPE DESIGN:.....

MAXIMUM FLOW AT BUILD OUT:..... gpm

MAXIMUM HEADLOSS AT BUILD OUT:... ft/1000ft

SPECIAL CONSIDERATIONS:.....

ASSUMPTIONS:.....

ALTERNATIVES:.....

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	11,292'	LF	158 $/ft	$1,781,663
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		6	EA	2,575 $/EA	$15,450
Service Line Connections		16	EA	1,000 $/EA	$16,000
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	23	EA	5,150 $/EA	$118,450
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	11,292'	8.00 $/sf	$451,680
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$2,409,243
Mobilization and Demobilization				**3%**	$72,277
Construction Cost Subtotal					**$2,481,520**
Contengencies for Unknown Conditions				**30%**	$744,456
Construction Cost Total					**$3,225,976**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$871,014

Capital Improvement Cost Total **$4,097,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction

Cost Estimating Worksheet

PATTERSON CIP WATER SYSTEM PROJECT DESCRIPTION

PROJECT ID: NP-6

LOCATION: Walnut Ave (to WQCF)

BRIEF PROJECT DESCRIPTION: Install 7910 lf of new 12-inch non-potable pipe to connect non-potable system to the WCQF.

MODEL REFERENCE:

PROPOSED PROJECT PHASING:

REASON FOR PROJECT: New non-potable pipeline to connect WQCF to the non-potable system to incorporated tertiary treated water.

PIPE DESIGN:

MAXIMUM FLOW AT BUILD OUT: gpm

MAXIMUM HEADLOSS AT BUILD OUT: ft/1000ft

SPECIAL CONSIDERATIONS:

ASSUMPTIONS:

ALTERNATIVES:

MAJOR ITEMS	DIA. (in.)	Quantity	Unit	UNIT COST	COST
Baseline Pipe Construction Cost					
Pipe (PVC)	4	0'	LF	67 $/ft	$0
Pipe (PVC)	6	0'	LF	79 $/ft	$0
Pipe (PVC)	8	0'	LF	91 $/ft	$0
Pipe (PVC)	10	0'	LF	124 $/ft	$0
Pipe (PVC)	12	7,910'	LF	158 $/ft	$1,248,048
Pipe (PVC)	16	0'	LF	203 $/ft	$0
Pipe (PVC)	20	0'	LF	259 $/ft	$0
Connection to Existing System		2	EA	2,575 $/EA	$5,150
Service Line Connections		0	EA	1,000 $/EA	$0
Gate Valve	4	0	EA	1,000 $/EA	$0
Gate Valve	6	0	EA	1,125 $/EA	$0
Gate Valve	8	0	EA	1,500 $/EA	$0
Gate Valve	10	0	EA	2,050 $/EA	$0
Gate Valve	12	16	EA	5,150 $/EA	$82,400
Gate Valve	16	0	EA	15,500 $/EA	$0
Gate Valve	20	0	EA	25,500 $/EA	$0
Traffic and Construction Productivity Factors					
Traffic Control		1	LS	$ 10,000	$10,000
Increased Traffic Control			0'	10 $/ft	$0
Surface Restoration					
Pavement Restoration		5' wide	7,910'	8.00 $/sf	$316,400
Remove/Replace Sidewalk		4' wide	0'	20.50 $/sf	$0
Subtotal					$1,661,998
Mobilization and Demobilization				**3%**	$49,860
Construction Cost Subtotal					**$1,711,857**
Contengencies for Unknown Conditions				**30%**	$513,557
Construction Cost Total					**$2,225,415**
Land Acquisition - Temporary Easement Cost		0' wide	0'	10 $/sf	$0
Land Acquisition - Permanent Easement Cost		0' wide	0'	25 $/sf	$0
Engineering, Administration, and Legal Costs[1]				**27%**	$600,862
Capital Improvement Cost Total					**$2,826,000**

ENR = 11,555 (S.F. August 2016)

[1]Includes 5% for Legal/Administration/Environment, 10% for design, 8% for Construction Management and 4% for Engineering Services During Construction